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• A NEW SERIES OF PLANT SCIENCE BOOKS •

*edited by Frans Verdoorn*

Volume XVI

# PLANTS *and* PLANT SCIENCE *in* LATIN AMERICA

**Plate 1. — A Botanical Collector in Colombia in the Seventies of the Past Century.** — *From* E. André's "L'Amérique Équinoxiale".

# PLANTS *and* PLANT SCIENCE *in* LATIN AMERICA

*edited by* FRANS VERDOORN

*in cooperation with* J. Acuña, R. H. Allee, J. Ashton, H. D. Barker, M. Bates, J. S. P. Beard, H. H. Bennett, A. Bevan, A. A. Bitancourt, A. Boerger, E. W. Brandes, M. Cárdenas, J. P. Carabia, H. J. Coolidge, Jr., W. Crocker, W. C. Darrah, G. Dawson, G. Dillon, A. Domingues, A. Dugand, C. W. Emmons, F. R. Fosberg, T. H. Goodspeed, G. R. Groves, E. Guenther, P. L. Guest, F. Hardy, J. G. Harrar, A. F. Hill, W. H. Hodge, L. R. Holdridge, C. L. Horn, I. M. Johnston, P. A. Kovar, C. A. Krug, J. Lanjouw, L. N. H. Larter, M. Lewy van Séveren, W. R. Lindsay, C. L. Lundell, P. C. Mangelsdorf, J. B. Marchionatto, K. S. Markley, H. A. Meyer, E. Molestina O., F. A. Motz, A. S. Müller, I. Ochoterena, L. R. Parodi, D. D. Paterson, Jesús Patiño N., R. L. Pendleton, F. W. Pennell, W. Pennock, H. Pittier, W. Popenoe, R. D. Rands, B. B. Robinson, J. T. Roig y Mesa, T. Rojas, B. Rosengurtt G., K. A. Ryerson, R. W. Schery, F. Shreve, C. J. F. Skottsberg, A. F. Skutch, A. C. Smith, L. B. Smith, P. F. Souza, G. Stahel, E. C. Stakman, P. C. Standley, H. Stehlé, J. A. Steyermark, R. G. Stone, H. K. Svenson, V. A. Tiedjens, L. A. Tortorelli, J. C. Th. Uphof, J. G. Verdoorn, A. Viehoever, M. L. C. Walle, Ll. Williams, L. W. Witt, *and* T. G. Yuncker.

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# FOREWORD

*For a number of reasons, more fully developed in the following essay (p. xv, seq.), the Editors of Chronica Botanica felt that an account concerning the vegetation and natural resources, as well as the present status and future of a number of branches of the plant sciences in Latin America, would be the most appropriate contribution they could make at present to the improvement of international relations and coöperation in the plant sciences, a field which presents in Latin America many problems of a great, often truly international, importance.*

*The aim of this collection of articles which we started in 1941 in Chronica Botanica was to give the agronomist, botanist, forester and phytopathologist (whether he be located in the Americas or in Europe) information which he may need when starting work on the wild or cultivated plants of Latin America. It was hoped that it might be still more useful for those who plan to go to Latin America to collect or to conduct research. The collection endeavoured to give some information concerning the present status of and the future possibilities and needs for research in the chief branches of the pure and applied plant sciences. In addition to data in his own field, the specialist will find much useful and stimulating information on vegetational and agronomic problems in general, on the organization of research, lists of books that he may consult, addresses of institutions and societies in the territory in which he is interested and which he may profitably contact, etc.*

*We succeeded in obtaining so much material for our collection of articles that we soon had much more than could find a place in Chronica Botanica. At the suggestion of several correspondents we then decided to bring together all articles on this subject, those published in Chronica Botanica, those not yet published, and many additional ones, in one volume, which we are presenting herewith.*

PART 1 *(pp. 1-260) consists primarily of articles not previously published. Only a few of the articles in this part have already appeared in the Chronica (but these have been revised by the authors in the meantime).*

PART 2 *(pp. 261-349) consists, with a few exceptions, of reprints (mostly somewhat revised) of articles already published in the columns of Chronica Botanica.*

*Like most volumes prepared under war-time conditions, this book is not complete and its various chapters are often somewhat unequal in concept. Some contain remarks, general considerations, and historical and bibliographical information which are missing in other chapters. One should remember that most of the chapters of this volume were originally planned as short articles for a periodical, rather than as chapters of a coöperative manual. Many of the authors who kindly contributed are engaged in special war projects, often in the field and far from library resources. The authors of certain chapters, shorter and less documented than others, should not be held in any way responsible for this relative conciseness. Had they not helped us, our volume would be much less complete and still less informative. In several cases I have not been able to obtain coöperation until I had elaborated in some detail along the lines of* NECKER'S *words: "Il ne faut pas que la crainte d'un défaut d'exactitude inévitable empêche de présenter un travail qui peut d'ailleurs être utile."*

*For a few chapters only I have not been able to obtain suitable help at all. I must confess with regret that I have not been successful in arranging*

*for an authoritative chapter on the historical development of the flora of the Western Hemisphere.*

*I do not flatter myself with the hope that my choice of plates and certain other details of typography will meet with universal approval. Being daily engaged in historical work, one tends to live partly in the past and finds there without doubt much which may seem strange to some of those whose mental activities are more centered in the present. Quite a little material of this kind was found in the Arnold Arboretum Library, a most resourceful place which, with* SCHIFFNER'S *office at the Rennweg and the Mountain Gardens and Forest above Tjibodas, I consider to be among the most inspiring spots where I have been privileged to work.*

*I should like to say a few words about Dr.* LANJOUW'S *List (pp. 225-235). Among the few useful things I have been able to do as secretary of the Botanical Section of the International Union of Biological Sciences, I think most fondly of the initiating of the* Index Herbariorum. *Started by the late Dr.* A. S. HITCHCOCK, *the material for this project was turned over to the Union. At my request and suggestion, Dr.* J. LANJOUW, *Curator of the Herbarium of Utrecht University, assumed the post of secretary of the Committee for Urgent Taxonomic Needs of the Union and Congress in 1935. In the following years he obtained worldwide coöperation (cf. Chron. 5: 142-150). I am glad to state that Dr.* LANJOUW *has been able to continue to work on this project in spite of the war years and I look forward with great expectancy to the day we may launch the first volume. There are, it appears, still quite a few institutions which have not prepared the necessary data for Dr.* LANJOUW'S *Committee. In most cases, without doubt, this was due to the fact that the directors did not understand the scope of the* Index Herbariorum *too well. To show what Dr.* LANJOUW *is preparing we decided to publish some kind of sample. As explained in detail on p. 224, we realize only too well that this list is not complete. On purpose we have not made much effort to complete Dr.* LANJOUW'S *list, as we wanted to show only what kind of Index he is preparing for us. I also felt that those institutions which had failed to take part in this international project should as a rule not be included in the list. I may add that we realize that our* Index Herbariorum *will never be complete if we have to rely only on the data submitted by herbaria. We will use supplementary ways and means to obtain additional data in due time, but we feel that the basic information can be obtained best from the curators of the herbaria of the world.*

*The attention of all readers is drawn to the detailed table of contents on p. 350 seq. As it was not feasible to prepare a subject index for our polyglot volume, it is important that every reader examine this table of contents with some care! It contains in Part 1 cross-references to Part 2 and vice versa.*

*Grateful acknowledgment should be made of the generous assistance of the Directors of the United Fruit Co. of Boston, Mass., and of a subsidy of the International Union of Biological Sciences to cover certain special editorial and production expenses.*

*In addition to the authors of the chapters of this volume (full information about their status will be found on p. 350 seq.), I should still like to thank Dr.* J. P. CARABIA, *Dr.* L. CROIZAT, *Dr.* G. DAWSON, *Dr.* R. E. SCHULTES, *Dr.* A. C. SMITH, *and* J. G. VERDOORN, *phil. nat. dra. for their never-failing help and assistance with the proofs, and Dr.* R. H. ALLEE, *Dr.* W. A. ARCHER, *Dr.* R. M. FIELD, *Dr.* L. HANKE, *Dr.* A. E. JENKINS, *Dr.* C. F. JONES, *Dr.* E. D. MERRILL, *Dr.* B. Y. MORRISON, *Dr.* W. POPENOE, *and Dr.* K. A. RYERSON *for their stimulation and advice.*

*The endpapers have been designed by Dr.* ERWIN RAISZ *of the Institute of Geographical Exploration of Harvard University. Several of the text illustrations were prepared by Mr.* G. W. DILLON *of the Botanical Museum of Harvard University. A number of maps from* JAMES' *"Latin America" (New York 1942) have been reproduced by kind permission of the copyright holders, the Odyssey Press, Inc., of New York City.*

WALTHAM, MASS.,
SPRING, 1945

*The Editor*

# *SUMMARY OF CONTENTS*

• For detailed table of contents see p. 350 seq. •

*In palmis semper virens juventus;*
*in palmis resurgo*

*Martius*

*A la memoria de*

VON MARTIUS,

***notable explorador de la América tropical del siglo diecinueve, quien, concertando la labor de los estudiosos de distintas nacionalidades, produjo lo que el sabio más sobresaliente jamás hubiera podido realizar por sí solo. Así enseñó a los hombres de ciencia que la cooperación y solidaridad internacional son necesarias, tanto para lograr éxito en las grandes empresas científicas, como para mantener una paz duradera y fecunda sobre la tierra.***

PLATE 2. — A VIEW OF THE COCONUT PALM VEGETATION, TYPICAL FOR THE NORTHEASTERN COAST OF BRAZIL. — *Courtesy Rev. Bras. Geogr.*

*Salve, fecunda zona,*
*Que al sol enamorado circunscribes*
*El vago curso, y cuanto ser se anima*
*En cada vario clima,*
*Acariciada de su luz, concibes!*
*Tú tejes al verano su guirnalda*
*De granadas espigas; tú la uva*
*Das á la herviente cuba:*
*No de purpúrea fruta, ó roja ó gualda,*
*A tus florestas bellas*
*Falta matiz alguno; y bebe en ellas*
*Aromas mil el viento;*
*Y greyes van sin cuento*
*Paciendo tu verdura, desde el llano*
*Que tiene por lindero el horizonte,*
*Hasta el erguido monte,*
*De inaccesible nieve siempre cano.*
*Tú das la caña hermosa,*
*De do la miel se acendra,*
*Por quien desdeña el mundo los panales:*
*Tú en urnas de coral cuajas la almendra*
*Que en la espumante jícara rebosa:*
*Bulle carmín viviente en tus nopales,*
*Que afrenta fuera al múrice de Tiro;*
*Y de tu añil la tinta generosa*
*Émula es de la lumbre del zafiro;*
*El vino es tuyo que la herida agave*
*Para los hijos vierte*
*Del Anáhuac feliz; y la hoja es tuya*
*Que cuando de süave*
*Humo en espiras vagorosas huya,*
*Solazará el fastidio al ocio inerte.*
*Tu vistes de jazmines*
*El arbusto sabeo*
*Y el perfume le das que en los festines*
*La fiebre insana templará á Lieo.*
*Para tus hijos la procera palma*
*Su vario feudo cría,*
*Y el ananás sazona su ambrosía:*
*Su blanco pan la yuca,*
*Sus rubias pomas la patata educa,*
*Y el algodón despliega al aura leve*
*Las rosas de oro y el vellón de nieve.*
*Tendida para ti la fresca parcha*
*En enramadas de verdor lozano,*
*Cuelga de sus sarmientos trepadores*
*Nectáreos globos y franjadas flores;*
*Y para ti el maíz, jefe altanero*
*De la espigada tribu, hinche su grano;*
*Y para ti el banano*
*Desmaya al peso de su dulce carga;*
*El banano, primero*
*De cuantos concedió bellos presentes*
*Providencia á las gentes*
*Del ecuador feliz con mano larga.*
*No ya de humanas artes obligado*
*El premio rinde opimo:*
*No es á la podadera, no al arado*
*Deudor de su racimo;*
*Escasa industria bástale, cual puede*
*Hurtar á sus fatigas mano esclava;*
*Crece veloz, y cuando exhausto acaba,*
*Adulta prole en torno le sucede . . .*

*¡Oh jóvenes naciones, que ceñida*
*Alzáis sobre al atónito Occidente*
*De tempranos laureles la cabeza!*
*Honrad el campo, honrad la simple vida*
*Del labrador, y su frugal llaneza.*
*Así tendrán en vos perpetuamente*
*La libertad morada*
*Y freno la ambición, y la ley templo.*
*Las gentes á la senda*
*De la inmortalidad, ardua y fragosa,*
*Se animarán, citando vuestro ejemplo.*
*Lo emulará celosa*
*Vuestra posteridad, y nuevos nombres*
*Añadiendo la fama,*
*A los que ahora aclama,*
*«Hijos son estos, hijos*
*(Pregonará á los hombres)*
*De los que vencedores superaron*
*De los Andes la cima:*
*De los que en Boyacá, los que en la arena*
*De Maipo y en Junín, y en la campaña*
*Gloriosa de Apurima,*
*Postrar supieron al león España».*

ANDRÉS BELLO
(ca. 1810)

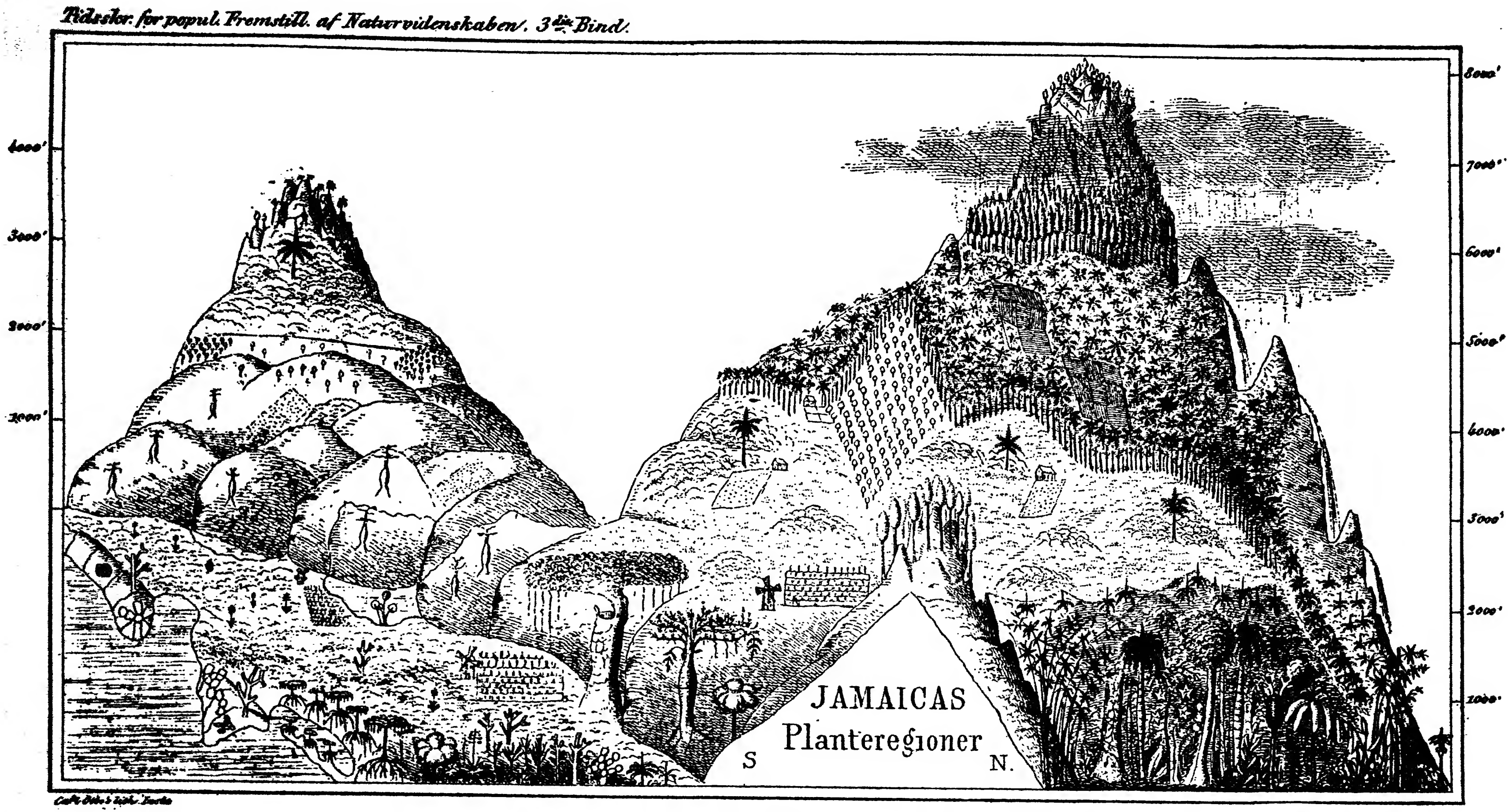


**Plate 3.** — An early attempt to illustrate the vegetational zones of a tropical island. — From A. S. Ørsted, "Jamaica, En Naturskildring" (1857). — *Courtesy Arnold Arboretum of Harvard University.*

*Introductory Essay*

# The Plant Scientist in the World's Turmoils[1]

*It is unnatural to be without a special love of the country of one's birth, just as a man has more affection for his family than for other families. But let our allegiance extend to the whole globe on which we travel through the universe, and let us try to serve mankind rather than our country right or wrong.* (LUMHOLTZ, Unknown Mexico 2:483).

I should like to preface this volume with a discussion of certain aspects of the plant scientist's rôle and place in the world. In doing so I will have to deal with matters of a controversial nature; to deal fairly with them I will endeavour to take solely the point of view of the student of international relations.

During the last months of the First World War, a period which — from many points of view — may be compared with the present, the plant scientists and zoologists of the world were less involved in the war effort than they are today. Nevertheless, as such addresses and papers as LYMAN's "Contributions of American Botanists for More Active Prosecution of War Work" (1918) and STEVENS's "American Botanists and the War" (1918) show, some of the foremost plant scientists of the United States were prevailing upon their colleagues to engage in activities which might help the war effort. At the time much consideration was given to the war from a biological point of view, as such publications as NICOLAI's "Biology of War" (1919) and PEARL's "Biology and War" (1918) testify. Just before the end of the war many interesting papers on the rôle of botany and biology in the post-war world were published. These included "Botany as a National Asset" (COULTER, 1917) and "Botany after the War" (DAVIS, 1918), and were followed by an unusual number of inspired discussions by men, most of whom are no longer with us, like LYMAN, PEIRCE, and GAGER. Though far be it from me to deny that during those years a number of biologists did accomplish useful things in such fields as pioneering in dehydration, raising the agricultural output, and discovering substitutes of vegetable origin, the foremost trend of thought, especially in the Allied countries, was concerned with biology in the post-war world, in human relations as well as in agriculture.

The Germans of that time were, comparatively, much more concerned with problems directly relating to the war effort than were their colleagues in the Allied countries. DIELS wrote an entire volume on botanical substitutes; HABER and other chemists revolutionized the gunpowder and fertilizer situation . . . .

In the discussions in Allied countries the educational and humanizing value of biology was stressed much more than it is today. Many believed that a better knowledge of, and better training in, biology might well revolutionize the citizen's attitude towards essential problems of life and human relationships. This hope has not materialized — and that, without doubt, is a reason for the sceptical and negative attitude of many of us today.

In one field, however, enthusiasm, understanding, and leadership on the part of the biologists of the Allied countries were hardly progressive. That in those Wilsonian years little was said in either British or American discussions about international work and relations in biology, and the re-establishment of international relations seems very strange to the historian. There was a much more patriotic (though not a soundly patriotic) tone in the discussions then than there is today, when it looks as though groups of men of science (not necessarily natural scientists) in Great Britain and the United States are at least as much interested in post-war international relations as are the large political groups. It was in 1919 that LOTSY's generous offer to combine the "Botanisches Centralblatt" (at that time — in spite of its name — a purely international journal and the official organ of the now defunct International Association of Botanists) with the planned "Botanical Abstracts" was turned down. This rejection killed that association and much that it stood for, and postponed for years a resumption of international relations work in botany, so enthusiastically started before the First World War by men like SCOTT, GOEBEL, FARLOW, VON WETTSTEIN, TRELEASE and many others. Before 1914 great and busy scientists in our field felt that they could afford to spend a few hours, from time to time, to international relations work.

When the Second World War broke out in 1939, scientific international relations had not yet fully recovered; in fact, they had by no means reached even their status of 1914 — this in spite of the many congresses, meetings and commissions in our field about which I have reported in great detail, in an effort to stimulate interest in them, in special sections of CHRONICA BOTANICA, Volumes 1-5. Reading those reports of the

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[1] Parts of this introduction have been published in *Nature* (Vol. 154:595-599, 1944: "Future of Biology in World's Affairs"), and the essentials have been read at a symposium on "Biologists and Rehabilitation", held by the Botanical Society of America and the American Association for the Advancement of Science, Cleveland, Ohio, Sept. 13, 1944.

years before the present War and comparing them with those from 1912-1914 creates the conviction that an unsound impetus was given during the years just before the Second World War by motives only slightly differing from national propaganda.

In this War the biologist has played a much larger part than in any previous war. Botanists, agronomists, zoologists, entomologists, psychologists, and bacteriologists have contributed to the war effort in larger numbers and in more intensive ways than ever before. When we listen to accounts of these activities, we gather that, both as a group and as individuals, they feel inordinately proud. I think that this attitude — which is, of course, fully justified in men in active service and those sacrificing their health or a career — is most incorrect for the majority of scientists engaged in so-called war work. Men of science form one of the few groups in society which know that the concepts and ideas by which politicians and the accepted organizers of human relations are guided are mostly wrong, based on misconceptions, old superstitions, and false intuitions. Yet the man of science has left not only the administration, but also most of the study of the administration, of human life and world affairs in the hands of people who know little, and who have been trained so poorly that they care still less, about what a century of progress in the science of life[2] has achieved. Therefore, I cannot help feeling that we scientists are at least as much responsible for the chaos of today as is any other part of society.[3]

The resources, strength and endurance of the United States, Great Britain, the U. S. S. R., and their allies are bringing this war to an end, an end which will place the scientist once again in a very favourable position, as he will remain free in the post-war world, not in all but in much more than half of the Allied territory. How will he use this freedom of thought and action?[4]

One of the resolutions of the United Nations Conference on Food and Agriculture states: "The natural sciences are a particularly fruitful field for international coöperation because they are themselves international; basic physical and biological laws are the same anywhere and universally accepted." This is true, but it is also true that coöperation demands an attitude which is not typical of the average biologist. Considering the matter psychologically, I am not far wrong in stating that most of the better workers in botany and zoology turned to this pursuit because early frustrating experiences resulted not in the normal, human response of aggression, but in a desire for isolation. It is perhaps a bit hard to demand now that these men become enthusiastic coöperators. We will, however, have to assume that at least some of them "have learned that we cannot live alone" and that even in nature research it is true that "united we stand, divided we fall."

Sometimes I speak of plant scientists, sometimes of biologists, sometimes of botanists. This inconsistency is not due to carelessness, but to a tragic fact, to the greatest professional problem we have: there are no longer biologists or even animal scientists and plant scientists.

There was a discussion some months ago in the columns of *Science* about whether there still exists today such a subject as biology. Some of the writers stated that it was a fraud to speak of biology any longer, as we always mean something else. There is, of course, such a subject as pure biology when considered from a purely scientific or philosophical point of view, but there are no longer professional biologists. There are only specialists in the various branches of the pure and applied plant and animal sciences. What makes it bad is that these specialists neither keep together nor think and plan together with reference to their professional interests as medical and chemical workers do. Though very large in number (22% of the scientists included in "American Men of Science" (ed. 7) are "Biologists" *sensu antiq.*), and not too poor in brains, our position both as a group and as individuals is extremely weak. As wage earners we are in many cases not able to give our families the comforts and education which we received in our youth or which the families of our friends in college receive; as scientists we have either to teach or to work in applied biology, with the result that many branches, especially of

[2] Also surprising, among many professional biologists, is the lack of knowledge of and interest in the psychological aspects of human progress, civilization, and especially the conflict between technology and society. While we do not necessarily have to agree with all the conclusions of this or that school of psychology and psychoanalysis, nevertheless a consideration of these conclusions will often show us a given problem in a new light. ("He was not dazzled by the illusion of the progress of civilization toward a goal of universal felicity. His *Civilization and Its Discontent* reveals unmercifully how everything that starts on the way to progress must sooner or later end in a vicious circle: the constant drain on the erotic drives and the deflection of the aggressive tendencies, both necessary to maintain and enlarge the domain of civilization, cause a growing discontent with it and its final breakdown. Civilization, present within ourselves in the guise of the superego, threatens to eat its own children", SACHS, H., 1944: FREUD, Master and Friend, p. 140).

[3] For a more detailed and illuminating discussion of this subject see WELLS, H. G., 1942: Phoenix, A Summary of the Inescapable Conditions of World Reorganization, pp. 192 (London).

[4] There are men, even among scientists, who consider the planning for peace in times of war something premature. Others do not feel that there is a difference between planning for peace and for war, both being forms of human politics and applied philosophy. Well may we say with HENRY WALLACE: "I believe the sensible and constructive course to take is this: Do everything we can to speed our drive for victory . . . . . At the same time, think hard and often about the future peace, because unless we and the other democracies have confidence in that peace our resistance to our enemies may not be strong enough to beat them.

"Thinking of the future peace, in other words, is not searching for an escape from the stern realities of the present, not taking refuge in airy castles of our minds. From the practical standpoint of putting first things first, at a time when there are not enough hours in a day and every minute counts, planning for the future peace must of necessity be a part of our all-out war program . . ."

descriptive biology, are in an anachronistic status; as a group we cannot reach the Government, still less exercise an influence commensurate with our knowledge.

*Mutatis mutandis,* this situation is the same all over the world. Therefore, it appears that the situation is the result of internal factors and that it cannot be changed easily, for example, by establishing professional biological societies, unions, etc., especially not as long as — another curse of biology — its great scientists continue as a rule to refuse to give professional guidance.[5]

With every generation an increase in specialization seems to become necessary. This may be really essential, but the result is that many workers spend their enthusiasm and greatest mental output in their youth, and end with years of not-too-inspired routine research. Great as the literature and body of facts of any branch of biology may be, I do not agree that all this specialization is necessary. The organization of most of our institutions is such that it forces the so-called free worker into a steady and dull routine.[6]

We all, but the administrators of research especially, should distinguish between *deep* and *permanent* specialization. But even if we feel that permanent and thorough specialization is necessary, can we not educate our pupils with the feeling that they are in the first place biologists, whatever they do, and specialists in some branch of the pure or applied plant or animal sciences in the second place? No improvement of the status of biologists is possible if we do not recognize and learn the very close interdependence between pure biology and applied biology on one hand, and between biology and world economy and government on the other hand. Also all biology, in contrast to physics, mathematics, etc., continues to have close ties with the humanities.[7] We cannot fulfil our mission if these facts are disregarded; we cannot raise a satisfactory crop of young biologists if we and they are not governed by this knowledge.

Speaking of agriculture in the post-war world, Dr. AUCHTER, of the U.S. Department of Agriculture, in a recent address emphasized (*1*) improved nutrition for human beings, (*2*) methods of breeding and the use of substances that regulate growth, (*3*) world exploration to obtain and maintain material for breeding purposes, (*4*) the changed fertilizer situation, (*5*) utilization of waste and by-products and (*6*) problems of insect and disease control. To them I should like to add research in a field about which we heard more at the end of the last war than we do today.

In spite of the lack of emphasis on international relations at that time, there were in the minds of our colleagues, a generation ago, many ideas about — or rather a feeling for — the necessity of closer relations between science and government (not necessarily human politics). We might call this borderland biopolitics. I miss a plea for it today. Is it because we have despaired of ever establishing such relations? Or is it a reaction against the close relations between biology and politics in the U.S.S.R. in which biology has occasionally been reduced to serfdom? If that is so, a word of warning must be expressed. To do so I just used the word *biopolitics* which will recall a related field of research, *geopolitics,* developed by and first used in the Axis countries, but not evil on that account, as shown by the ways it is now being developed along purely scientific channels by American scholars. Biopolitics and geopolitics may well be the ways along which scientists will find it possible to reach those groups which they hitherto failed to influence.

It is not true that the two World Wars are simply conflicts between have and have-not nations; yet the conflicts between these two groups are more responsible for the twentieth century chaos than are any other conditions. The practical politician will deny this vehemently; the scientist knows better. H. G. WELLS in 1940, in "The New World Order," considered it one of the most important causes of war. The scientist, the only reliable authority of natural resources[8] and the possibilities of their development, may well contribute a major share to the establishment of a durable peace. He also knows that a durable peace will have to be plastic, a consideration which the practial politician again considers absurd.

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[5] We must recognize a third great curse of biology: the fact that the proportion of research workers in pure biology to those engaged in routine or highly applied research work is less favorable than in many other fields of science. For a number of reasons, the routine workers (*i.e.* teachers, most of the experiment station workers, professional organizers of various sorts, and also the amateurs) seem to produce less research work with each generation (*cf.* POSTHUMUS, O., 1937: De Natuurwetenschappelijke Instellingen, hun tekort en hoe dit te verhelpen? Pp. *7*, Soerabaja & Bussum). — For a spirited general discussion of the problem, *cf.* SIGERIST, H. E., 1944: The University at the Crossroads (Bull. Hist. Med. 15:233-245).

[6] I do not intend to deny for a moment that the only way to make important progress is by having all thoughts concentrated on one central interest, but I do deny that anyone will profit by continuing to concentrate thus for decennia without extensive excursions into other fields.

[7] *Cf.* FERDINAND COHN's immortal words: "Ich kann wohl die Anerkennung für mich in anspruch nehmen, dass ich die Botanik, in deren Pflege und Lehre ich meinen Lebensberuf gefunden habe, niemals also ein in sich abgeschlossenes, isolirtes Fach, sondern im Zusammenhang mit der gesammten Naturwissenschaft, gleichzeitig aber auch in engster Beziehung zu den Geisteswissenschaften aufgefasst habe. Wenn die Botanik gemeinsam mit der Zoologie die Probleme des Lebens erforscht, stützt sie sich auf Physik und Chemie als ihre Grundpfeiler, tritt sie mit der Geographie und Geologie in den Wanderungen und den Wandlugen der Flora in Verbindung, greift sie in tausendfältigen Beziehungen hinein in das Gebiet der angewandten Wissenschaften, ist sie aber auch verknüpft mit der Entwickelung der Cultur, die in der Geschichte und Literatur aller Völker ihren Ausdruck findet. Diese nach allen Seiten hin ausstrahlenden Beziehungen der Wissenschaft von den Pflanzen haben mich von jeher in Berührung gebracht mit den Vertretern der verschiedenen Wissenschaftszweige . . . . (COHN, P., 1901: FERDINAND COHN, p. 241).

[8] *Cf.* also MATHER, K. F., 1944: Enough and to Spare . . . , pp. 186 (New York).

Now let us consider the aims of international coöperation in science:[9]

(*1*) The exchange of information (scientific, professional, and practical) in such a way that it will be available to anyone who can profit by it.

(*2*) The attainment of objectives which individuals or scientists of a single institution or nation cannot accomplish. These may be either in pure or applied scientific research, or they may be coöperative scientific or practical publications.

(*3*) The forming of an *esprit de corps* which may, at least at some time and at some place, counteract the evils of human international politics and contribute to the establishment of a commonwealth of nations.[10, 11]

How can we best accomplish these aims?

(*1*) By the oldest and most important form: the publication of original research, in which every scientist takes part, uninterrupted even by war, every time he has an article or a book published.[12]

(*2*) By abstracting journals, international as well as regional.

(*3*) By international congresses and meetings.

(*4*) By international societies or commissions responsible for the organization of international coöperative research. In biology most research is individual, or at most institutional; whereas in other fields of science, *e.g.* astronomy and geödetics, research has developed markedly along lines of direct coöperation, national and international.

Though it is clear that most research in biology will remain quite individual (this should be recognized as the cause of the comparative lack of interest of many foremost biologists in international relations work), there are many scientific and especially applied scientific problems which could be more easily and better solved by some form of international coöperation. In taxonomy, for example, the terrible status of exotic cryptogamic taxonomy[13] cries for some kind of concentrated attack; in plant pathology, a study, on an international basis, of the methods of disease control is greatly desired; in horticulture, an international centralization and further experimentation on the results obtained by the use of hormones in propagation has been asked for by the Permanent Committee of the International Horticultural Congresses.

(*5*) By international societies or commissions responsible for the organization of practical international activities. In botanical and zoological nomenclature the need for such coöperation was felt at so early a time that much has already been accomplished in this field. There are, however, many other things which could and should be done in the same way: the unification of botanical terminology, colour codification, etc.

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[9] For a list of U.S. organizations interested in international affairs see SAVORD, R., 1942: American Agencies Interested in International Affairs, pp. 200 (New York).

[10] Some years ago I formulated the aims in a more naive way as follows: —

*a.* Organization of Congresses: Occasions for the exchange of opinions, making of new contacts, etc. Too much time is still given at these meetings to lectures and too little to symposia, informal round table discussions and constructive meetings of small groups of specialists.

*b.* Organization of scientific and technical coöperation between research workers in different countries, both between investigators in the same field and between investigators in different fields (borderland research).

*c.* Attainment of uniformity in various respects: scientific terminology, form of publications, etc., etc.

*d.* Improvement, recognition, and consolidation of the position of scientists.

*e.* Collaboration with other leading scientific organizations to solve questions of general interest (*e.g.* the language problem in scientific publications) and to influence legislation in matters of human welfare. (Chron. Bot. 2:5-6, 1936).

For a stimulating, recent discussion on the general aspects of this problem see KANDEL, I. L., 1944: Intellectual Coöperation: National and International, pp. 78 (New York).

[11] For more detailed views from the biologist's point of view see HUXLEY, J., 1942 (etc.): On Living in a Revolution, pp. 242 (London), also CARLSON, A. J., 1944: The Science of Biology and the Future of Man (Science 100:437-439).

[12] I find an increasing assumption that scientific publications, not research or knowledge, are the most important thing today. We all know that the number of publications is increasing more rapidly than our real knowledge. In two fields with which I am familiar enough to express a judgment, bryology and history, about half the papers of the last forty years have presented only material that will need revision, checking, or completion, and that therefore does not really add materially to our knowledge. A single monograph or a single well-planned handbook could have been prepared in the same time now wasted on many little papers. Unfortunately for many of us, the question no longer seems to be how to contribute best to the advancement of science (the fact that many of us can contribute better to our science as a whole by various forms of organizing work is also too often forgotten), but rather how to make the best impression.

[13] The status of many institutions of systematic botany in the U.S.A. and elsewhere (especially in cryptogamic botany) is still such that their curators and supporters could, with few changes, make use of an old editorial: "The impression that . . . . . University is exceedingly well endowed may be true enough in general, but it is very far from being true of the Herbarium. We have the somewhat anomalous case of the most famous herbarium in . . . . . , for many years under the direct care of the most distinguished botanist in . . . . . , and in the possession of the oldest and nearly the wealthiest unversity of . . . . . , living, last year, on a beggarly income of . . . . . out of which the curator is paid, the collection increased and kept in order, and the library kept up with the times! The final touch to this showing is that . . . . . of this amount was derived from the gifts of Dr. . . . . . himself . . . . . To an outsider it looks as if the university was making a rare bargain in devoting . . . . . of its own income to the maintenance of so famous an establishment as the . . . . . herbarium and library. Many a college in this country would be willing to give ten times that amount annually for the support of an institution which wields such an influence over . . . . . botany. . . . . . botanists have no sympathy with . . . . . University in this matter, but they do have a lasting pride in the great collection of plants it possesses, and a still stronger love for the memory of him who made it what it is. For this reason they should be ready to use their influence towards securing a proper endowment. If endowment for botanical research is a desirable thing, the endowment of the . . . . . Herbarium will secure the largest amount of botanical work for the least outlay of money. It requires a vast amount of money to found such an establishment, even were such a thing possible, but it does not require very much to make such an establishment productive when it is already founded. . . . . ." (Bot. Gazette 15:99, 1890).

Such work as has been initiated by RECORD's International Association of Wood Anatomists could usefully be done in many other fields. A special war-time problem — and an immense one — is the reconstruction of herbaria and botanic gardens destroyed by the war; this is an international, not a national task.

(*6*) By publications not reporting the results of scientific research (either in original form or in abstracts), but bringing together various kinds of information and intelligence. In some cases these may be only stimulating; in other cases, of direct use for the research worker. Publications of this type have played a great part in biology; and I have always been especially interested in them.[14] We may distinguish:

(*a*) Address-books, either the old-fashioned lists of research workers or the more modern combination of such lists with a census of current research.

(*b*) Indices of various kinds; *e.g.* the *Index Herbariorum,* started by Dr. HITCHCOCK and now actively continued by Dr. LANJOUW.

(*c*) Such journals as the early *Botanische Zeitung,* early *Botanical Gazette, Dörfleria,* the *Chronica Botanica* when it was published as an "International News-magazine." Such journals, which bring together various kinds of information and intelligence, discussions,[15] notes, news, etc., have in the past always been published by individuals who after some time could not continue to give them the necessary time and money. They should, of course, be the official professional organ of an international society.

(*d*) A very great need exists also for a new and complete Guide to the Literature of the Plant Sciences. This also will be possible only with international coöperation.

(*e*) Then there are many publications semi-scientific, semi-practical, like the "Index Kewensis" and "Index Londinensis" and my planned "Index Botanicorum", which were formerly compiled on an institutional or national basis, but which, in the future, will probably ask for an international effort.

None of these things in itself is very important, but together they make a complex mass of activities both inspiring and helpful, and well worth the effort, even if we realize that to do this work well some of those who will do it will have to give up projects in pure research dear to their heart.

Just as a commonwealth of nations, the goal of almost all thinking men, is not yet in sight, it is clear that the time for some of the activities just enumerated is not yet here. The tendency of human development, in any field whatever, is, however, toward greater unity. Before there can be anything like a world-embracing commonwealth of nations, regional commonwealths may be more immediately feasible. Pan-Europe as planned by BRIAND and COUDENHOVE KALERGI is one of them; a united Western Hemisphere as planned by SIMON BOLIVAR and HENRY CLAY, and to some degree established by SUMNER WELLES, is another. One does not have to be very familiar with international politics and relations to realize that a united Western Hemisphere is one of the greatest conceivable guarantees of a durable peace. Unfortunately we have learned during the past years that differences in race, temperament, and economic interests make a united Western Hemisphere — which, at no time, seemed too utopian — not so easy to accomplish.

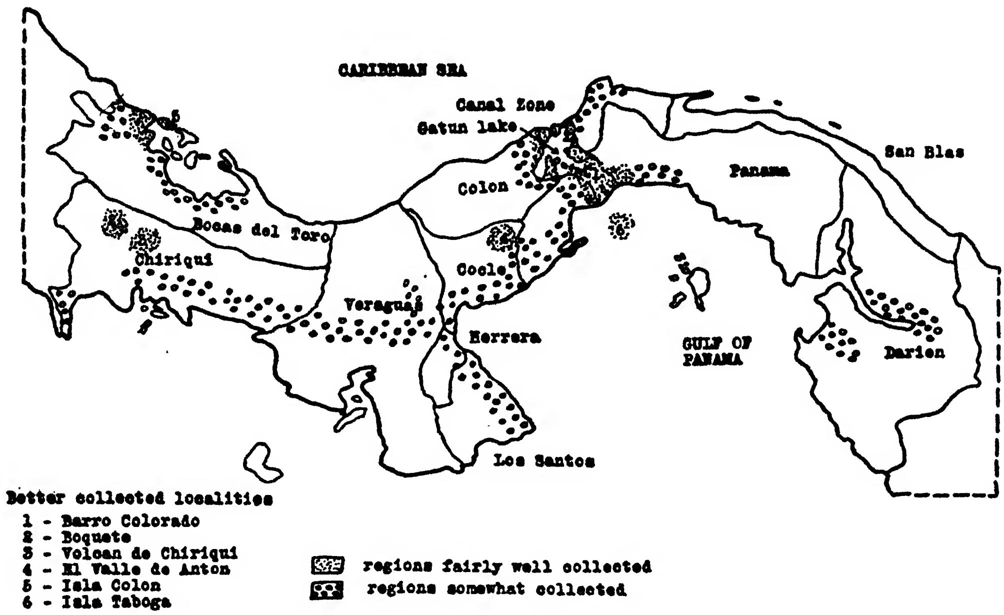
And here the biologist meets opportunities such as he has seldom, if ever, met before. Agriculture, biology, and medicine are fields in which Inter-American coöperation has an opportunity to do things so great that no one can question their usefulness and need; moreover, they are things which have a very strong bearing upon Inter-American economic and political relations.[16] Though many of us in the countries of the Western Hemisphere realize these simple facts and this dramatic opportunity thrown in our lap, not too many of us seem aroused, in spite of the support of the Government and our large foundations (and you know that the large foundations never bet but on a sure winner!). Is it due to the scientist's intuitive reluctance to get mixed up in Government projects?[17] God help him, that he may see his opportunity and duty, for never before has he been in such a position to influence with simple means and little, if any, sacrifice the course of development of the Western Hemisphere directly and the world at large indirectly.

[14] In this century of wars (in which even today, toward the end of the Second World War, little is being done to solve the basic causes of the current world conflicts, when we already clearly perceive the spectacle of nations striving for self-sufficiency, *i.e.* economic chaos, *i.e.* World War III *seq.*), publications are for several obvious reasons the most attractive and successful form of international relations work.

[15] Interest in discussions (except in the field of nomenclature) of general and professional subjects is not great among plant scientists. Some fifty years ago COULTER wrote: "Botanists are a peaceable folk, so peacable, we are almost inclined to add, as to be apathetic. They seem so averse to anything that has even the semblance of discussion that they will not even express an opinion lest it lead to controversy. If induction is worth anything, we can substantiate this by adducing a hosts of facts on which it is based. One has only to look back over the file of the Gazette to find that in the past five years there has been suggested numerous questions and movements, some of them of great interest to botanists. These the Gazette has presented, sometimes editorially, sometimes through its 'Open Letters', and regarding some it has invited and even urged discussion for the guidance of those having the matters in charge. We cannot at this writing recall a single response to these invitations! . . . ." (Bot. Gaz. 17:128, 1892).

[16] For a short interesting account on the plant resources of tropical America and their historic influence, for the general reader, see COOK, O. F., 1932: The Debt of Agriculture to Tropical America (Annual Rept., Board of Regents of Smithsonian Inst., Washington, D.C., pp. 491-501).

[17] Among biologists all over the world there is a feeling that relations with government (I do not mean any specific political group) should be avoided whenever possible. This may be a sound attitude from the point of view of pure research; from all other points of view it is a mistake. It reveals poor ability to read the




BOTANICAL EXPLORATION OF THE PANAMAS, *cf.* NOTE 19.

Much has been written during the past years about the form, aims, and scope of inter-American coöperation[18] in the pure and applied plant and animal sciences. I will restrict myself to a few remarks and desiderata:

(*1*) Coöperative studies of the flora and fauna of tropical America are necessary and more workers must be found for this work, even if it means some discontinuance of research of the Old World tropics.[19, 20]

signs of the times. Who should know better than the biologist that with the development of organisms their ecology becomes more and more intricate?

The structure of human society has become so complicated that it can no longer function well without regulation. This is not a political creed; it is a fact which we can observe all over the world. Whatever the dangers of collectivism are, the government—to use a simple colloquialism — is there to stay, and we biologists had better make of this opportunity what we can.

[18] In this connection mention may be made of the Caribbean Research Council, established at a meeting of the Anglo-American Caribbean Commission held in Barbados, B.W.I., March 21-30, 1944. Dr. ERICH ENGLUND, of the Division of Foreign Relations, U.S. Department of Agriculture, is to serve as Chairman of the Council, with Dr. CARLOS E. CHARDON, Director of the Institute of Tropical Agriculture of Puerto Rico, serving as Chairman of the Section on Agriculture, Nutrition, Fisheries and Forestry. Dr. ERIC WILLIAMS, native of Trinidad, graduate from Oxford, and Professor at Howard University, is Secretary to the Council. Dr. CHARDON and Professor D. D. PATERSON, of the Imperial College of Tropical Agriculture in Trinidad, are at present making a study and joint report of the agricultural research centers within the Caribbean area on behalf of the Council, with a view of securing a more effective integration of research projects and more personal contacts between research workers.

The Anglo-American Caribbean Commission, with Mr. CHARLES TAUSSIG as Co-chairman of the American Section, and Sir FRANK STOCKDALE as Chairman of the British Section, are actively coöperating in the formulation of post-war planning in the Caribbean. Representatives of the Netherlands have also been attending the meetings. The offices of the Commission are in 810-18th Street, N.W., Washington, D.C.

For more information on Anglo-American collaboration in the Caribbean region *cf.* Nature 153:320 (1944).

[19] In 1907 L. M. UNDERWOOD wrote: "The writer is neither a prophet, nor the son of a prophet, but perhaps the present is as good a time as any for prophesying, and this is his prophecy: Before another generation of botanists shall have come to the front, American botany will have fully entered into its proper heritage, the flora of pan-America — and this future flora of 1937 will include in it the one remaining botanical dark continent of all the world — South America — and the geographic limits of this flora will be Behring Strait and the Strait of Magellan". (The progress of our knowledge of the flora of North America, Popular Scientific Monthly 70:518, June 1907).

Today one would hardly dare to prophesy how many generations will have to pass before the flora of South America will be "adequately" known. How much field work remains still to be done may be gathered from the accompanying map showing the regions of Panama "which have and have not been collected" (*courtesy of* R. W. SCHERY, 1942). — In cryptogamic botany this will certainly take several generations!

It is the opinion of the writer that the study of the flora of tropical America could be greatly stimulated by a number of generic floras (for flowering plants as well as for the major groups of cryptogamic plants).

[20] Experience has unfortunately shown that hemispheric scientific societies are difficult to establish and still more difficult to develop. At one time we had a hemispheric microbiological society, later a hemispheric soil science society (Agric. in the Ams. 2, 9, 1942), not to speak of the hemispheric agricultural society. The fact that these three societies all remained in an embryonic state should not be misinterpreted as an ill omen for other societies. None of them organized a journal, and experience has shown that it is always difficult to keep a society going when its membership does not receive a periodical publication of interest to it.

(2) Students must be exchanged on a larger scale.[21, 22, 23]

21 A number of colleges have in recent years established "Divisions of Latin-American Relations". It seems regrettable that these divisions are in nearly all cases restricted to politics, the humaniora, etc. But in this case again, workers in the natural sciences are most to blame; they lacked vision.

Mention should be made of the Escuela Agricola Panamericana, energetically organized by Dr. WILSON POPENOE. This institution, situated twenty-five miles from Tegucigalpa, capital of the Republic of Honduras, opened its doors on September 1, 1943, with seventy-four students representing seven countries — Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama. Its establishment was made possible by a gift of $500.000 from the United Fruit Company of Boston. It is governed by a board of directors composed of SAMUEL ZEMURRAY, president; W. LATIMER GRAY, secretary-treasurer; THOMAS BARBOUR, THOMAS D. CABOT and T. JEFFERSON COOLIDGE. Operation is carried out through a board of regents, of which the members are WILSON POPENOE, FERNANDO CASTRO C., LUIS LANDA, LUIS PEDRO AGUIRRE, DORIS ZEMURRAY STONE, W. L. TAILLON and WALTER E. TURNBULL.

All students enjoy full scholarships, including board, lodging, clothing, laundry service, medical attention and tuition. Equipment includes 3,500 acres of land, lying between 2,500 and 5,000 feet in elevation; a main building known as "Zemurray Hall"; dormitories, a dining hall, residences for the staff, a modern dairy and cold storage plant and various minor structures.

In founding the Escuela Agrícola Panamericana it was the purpose of the United Fruit Company to coöperate in a practical manner toward the further development of agriculture in the Latin American countries. To this end the school not only furnishes instruction to a considerable number of Latin American (chiefly Central American) youths, but also conducts experiments, especially with a view toward the introduction of new crop plants and improved varieties of those already cultivated, the diversification of tropical American agriculture and the improvement of the tropical dietary.

In choosing the teaching staff, especial care has been taken to select men with long practical experience in tropical agriculture. All students do classroom work only in the afternoons, the mornings being spent in field practice. The full course requires three years, following which an opportunity for specialization is given those who have demonstrated unusual ability.

22 The Union of American Biological Societies has published very recently a most useful booklet in Spanish and Portuguese ("Organización de los Estudios Superiores de Biología en los Estados Unidos" and "Altos Estudos e Pesquisas no Domínio das Ciências Biológicas nos Estados Unidos"). This deals not only with the general organization of graduate work in biology in colleges and universities of the United States, but also with such subjects as biological field stations, agricultural experiment stations, biological societies and their meetings, biological publications, and the opportunities for securing financial aid through fellowships and scholarships. It is hoped that the booklet will be of service not only to young Latin American biological students who contemplate coming to the United States for advanced study and research, but also to Latin American professors who wish to spend a short sojourn in the United States at a biological field station or in attendance at biological meetings.

The booklet has been prepared by a Committee of American Biologists, with E. G. BUTLER of Princeton University serving as Chairman. Publication and distribution of the booklet is being carried out directly by the "Union of American Biological Societies."

With reference to the chapter on Biological Stations (Ed. hisp., p. 17), I may draw the attention to HOMER A. JACK's forthcoming "Biological Field Stations of the World" (Chron. Bot. 9, No. 1, *in press*).

In the chapter on Biological Publications (Ed. hisp., p. 24) mention is made in some detail of *Biological Abstracts*. Not a word is said of the new monumental *Bibliography of Agriculture*, issued by the Library of the U.S. Dept. of Agriculture (order from the Superintendent of Documents, Washington 25, D.C., annual subscription price for two volumes $3.75), which, from certain points of view, is not less, if not more, useful to the biologist.

With reference to the chapter on Fellowships (Ed. hisp., p. 27) attention may be drawn to certain information presented by Dr. K. A. RYERSON in his chapter on pp. 236-237 of this volume.

23 I have found among many North American students an assumption that, to do any kind of useful work relating to Central and South America, it is necessary to start with a trip through a number of the Latin American Republics. This attitude is ridiculous. There are many cases in which such a trip may be useful, especially after some years of study; in many other cases it is most certainly not a necessity. Our libraries and museums have material for generations of students of Latin America, without the slightest necessity for a visit south of the border. A good basic education seems more desirable than a hurried trip south. I may recall, to illustrate, the case of one of the greatest students of Mohammedanism, VAN VOLLENHOVEN, who never left his quiet study near the University of Leyden.

(3) The problem of a common language[24] must be solved in some way. Very probably it will find its solution best if the Latin American scientists make an increased use of English in their scientific publications and correspondence abroad. Their North American neighbour, however, must be able to read Spanish, both to understand the publications of his Hispanic colleagues and to appreciate their culture, which differs considerably more from the North American than *e.g.* the British or Scandinavian.

(4) An inter-American professional biological journal, with articles and notes in the four languages, if possible backed by an inter-American biological society, seems desperately needed to establish a common meeting ground.

(5) An inter-American biological station of the Woods Hole type, somewhere in Latin America, could do much good, especially if organized by biologists and agronomists on a truly inter-American basis. It is very sad that the Inter-American Institute of Agriculture has not been organized by representative scientists. With the same means and effort something better could have resulted. But the biologists of the Americas are also at fault for having watched (or not having watched at all) the development of this institute with such an utter detachment.[25, 26]

24 It is regrettable that there is not a good Spanish-English and English-Spanish dictionary of botanical terms. There are, however, several good Spanish textbooks, with indices and glossaries. — A large coöperative *Diccionario de Botánica* is being prepared at present in Spain. A number of well-known continental textbooks (VON WETTSTEIN, STRASBURGER, etc.) have very recently been published in Spain in careful translations which will be invaluable for those looking for correct Spanish equivalents of English terms.

25 Many botanists of today do not know of the early efforts to found an American Tropical Laboratory (*cf.* Bot. Gaz. 22:415 and 494, 1896, etc.), culminating in the establishment of a tropical biological station (in 1903) at Cinchona, Jamaica (*cf.* MAXON, W. R., 1922, Smiths. Rept. for 1920, p. 529; HARSHBERGER, J. W., 1902, Plant World 5:41, etc.).

Still much less is known today of the grandiose plans of LUIGI BUSCAGLIONI, who planned a second "hortus bogoriensis" on the Amazon (ca. 1900), traveling widely to obtain sympathy and support (for a pathetic account

I have devoted much space in my CHRONICA BOTANICA for the past few years to the promotion of inter-American relations and have undertaken the editorship of this volume with the hope that it may exercise some useful influence along these lines. A single individual, however, cannot do very much. Needed are an inter-American biological society, an inter-American biological journal, and an inter-American biological station; the latter will assure us of more satisfaction than merely a pleasant scientific holiday.

The biologists of the United Nations are, or will soon find themselves, in a truly unique position.

Some of them will have the opportunity of assuming leadership in the conduct of international relations work, with its profound implications.

A group of them can be instrumental in assisting in making the Western Hemisphere strong and influential, one of the least Utopian guarantees of a durable peace.

And they all will be in a position to assist with the creation, not of a planned supreme State, but a government of free responsible men, which will guide human relations and world affairs according to the laws of living Nature, as discovered and set forth by biologists.

F. V.

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of his efforts *cf.* Nuovo Giorn. Bot. Ital. 9:1-32, 1902).

For the account of another international project, which failed to materialize, *cf.* J. FÉLIX 1908: Projet d'un Institut International de Biologie générale et de Plasmogénie universelle (Mem. y Rev. Soc. Cient. "Antonio Alzate" 26:297-304).

A plan to establish a British tropical research station at Jamaica has recently been developed by V. J. CHAPMAN (Nature 152:47, 1943).

[26] Discussing the principles and basic philosophy of inter-American coöperation in the field of agricultural research and extension, Ross E. MOORE of the U.S. Office of Foreign Agricultural Relations recently stated: "I feel very strongly that the entire program of tropical experiment stations should have its roots firmly fixed in the actual needs of tropical agriculture. In this connection, it becomes immediately obvious that nationals of the countries in which these stations are to be located must have active participation at every stage in the formulation of plans and in their execution. Whatever may be the good intentions of those of us from the United States who desire to collaborate with our colleagues from the other American republics, it is important to remember that none can appreciate the needs of a given locality better than those who have been identified all their lives with that locality.

"A second important consideration is that experiment stations should be planned as integral parts of larger systems for the betterment of the economies of those countries which they are meant to benefit. For instance, it is absolutely essential that adequate roads be built in order that the experiment stations may not find themselves in the position of developing the cultivation of products for which there is no means of transportation to other regions in the Americas where these products may be needed. When I speak of roads I refer not only to main trunk roads connecting important centers of a country, but also to the smaller feeder roads which are just as essential in providing an adequate network of transportation.

"A third factor which affects the entire situation and without which there could hardly be any sensible discussion of developing tropical agriculture is that of the human element. The scarcity of population precisely in those regions which hold forth great possibilities for development is too well known to you all to require further explanation. This situation, naturally, brings with it three important problems. The first is the need for importing more people to the regions where it is desired to undertake agricultural development. The second, no less important, is the training and guidance of these people. The third is that of sanitation and public health facilities. These are tasks in which both the countries affected and the countries which have had more extensive experience in solving similar problems can effectively collaborate.

"A fourth problem and one which underlies most of the others, is the need for planning agricultural development of the Americas on a long-time, permanent basis rather than for short periods which simply reflect a temporary emergency. Since agriculture is so inextricably bound up with other factors of social development, it cannot be planned on a basis which would endanger the existence of community life built up in the various countries on the basis of present needs.

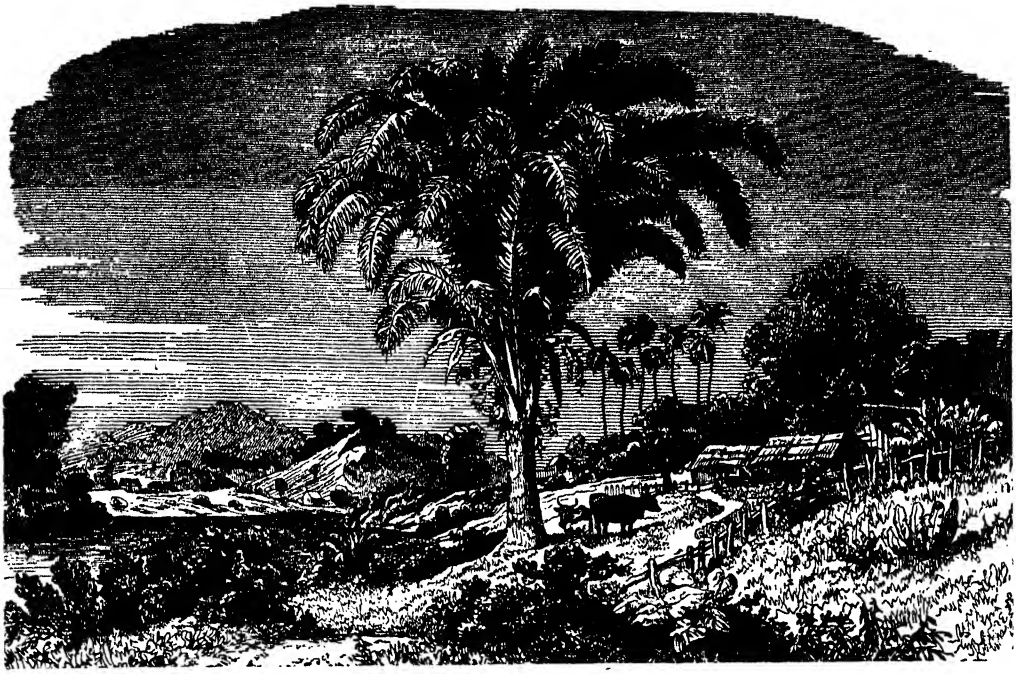
"A fifth problem is that of providing for subsistence crops and animals for ordinary family requirements which will take care of the people whom it is expected to engage in the development of complementary crops (which take a long time to come into production), while they are waiting for this to happen. There are a number of regions in which the growth of these complementary crops is envisaged at a considerable distance from present centers of population and it is therefore absolutely essential to the welfare of the people who are to participate in these undertakings that they be adequately supplied with the means of sustaining life during the developmental period.

"It is obvious that extension and investigation work must go on hand in hand simultaneously with colonization and cultivation. No one of these can be said to be independent of the others. The progress of each will be definitely affected by the success of the others.

"The most logical procedure would seem to call, in its initial stages, for the building of roads from seaports already in existence or other shipping points to be set up, penetrating into the forests from which settlers could take out the rubber and other raw products which now exist there.

"In this development, the experimental station is basic. Such a station, properly organized and manned, can scientifically guide the growth of an entire region on the basis of facts which are already known, or which it can unearth in the region by experimentation.

"Among the problems to which such a station could address itself are: cultural practices, the selection and testing of varieties, animal feeding, fertilization, erosion control, the best times for planting, crop rotation, and farm management. . . . ."



FARM SCENES IN BRAZIL (MIDDLE 19TH CENTURY). — 1, ALONG THE ITAJAHY RIVER. — *From* TSCHUDI'S "Reisen durch Südamerika".

*Introductory Bibliographical Notes, 1:* **A Selected List of Travel Books of Botanical Interest:** — The fact that most young botanists preparing to go to Central or South America spend so little time reading the experiences of outstanding colleagues of the past has often surprised me. It is, of course, more important to get certain other kinds of information first, and the time of preparation for many travelers is not long. Yet, I cannot help feeling that stimulation and profit may be derived for all interested in Latin American affairs from the classic accounts of botanical and agricultural exploration in Central and South America. Many of these books are not difficult to obtain and hardly expensive. In the hope that it may be of some assistance to those interested, I have drawn up the following concise list of Latin American travel books — books of a direct interest from a botanical explorer's point of view. This was not too difficult, as I have been collecting data for a bibliography of botanical travel books for years (many of them contain valuable historical data, often overlooked). The Arnold Arboretum Library, that fine and resourceful legacy of CHARLES SPRAGUE SARGENT, where one may spend hours and hours discovering treasure after treasure, has an unusual collection. In the course of the years I personally have also gathered quite some material. The following bibliography is based chiefly on these two collections. I have listed about one-third of the books one might list in a more or less complete bibliography, eliminating the titles which are difficult to obtain, of only little interest, or which may, for our purpose, be supposed to have been superseded by books more readily available. A very few classic regional descriptions, based on personal experiences, have been included. With certain exceptions only books, no articles or periodicals or short pamphlets, have been listed.

AGASSIZ, J. L. R. and J. E. CABOT, 1868, etc.: **A Journey in Brazil**, pp. 540 (Boston, etc.). — A very readable account of a general, not merely zoological, interest!

ANDRÉ, ED., 1883: **L'Amérique Équinoxiale.** — There may exist more than one edition of this extremely readable narrative. An illustrated edition was published in "Le Tour du Monde", a French geographical magazine (vol. 34, liv. 861 *seq.*). This has drawings by RIOU, BAYARD, and others, which make it one of the most unique travel accounts ever published in our field (*cf.* plates 1, 14 and 33 and the vignette on p. xxviii (also CHRON. 8, 4:425, 1944). ANDRÉ published also a more formal report which gives more accurate data about his collections, route, etc. (Rapport sur une mission scientifique dans l'Amérique du Sud, pp. 38, Paris: Imp. Nat., 1878).

APPUN, C. F., 1871: **Unter den Tropen ....**, 2 vols., pp. 559 + 598 (Jena). — Travels in Venezuela, British Guiana, and Northern Brazil (1849/1868).

BACKEBERG, C., 1930: **Kakteenjagd zwischen Texas und Patagonien**, pp. 127 (Berlin). — A well-illustrated account by one of the most successful, professional cactus collectors. The same author wrote "Durch die unbekannte Kordillere" (*n.v.*). There exist several other books of this type, and many shorter narratives will be found in the journals and annuals of the various cactus and succulent societies.

BATES, H. W., 1863 (etc.): **The Naturalist on the River Amazons**, 2 vols., pp. 351 + 417 (London). — This "Record of Adventures, Habits of Animals, Sketches of Brazilian and Indian Life, and Aspects of Nature under the Equator, during eleven years of Travel" is chiefly zoological, yet extremely readable and of a broad, general

interest. It has, without doubt, been read in the past by more naturalists than any other account of Amazonian exploration.

BELT, T., 1874 (etc.): **The Naturalist in Nicaragua: A Narrative of a Residence at the Gold Mines of Chontales; Journeys in the Savannahs and Forests,** pp. 403 (London, etc.). — One of the most famous Central American travelogues.

BODDAM-WHETHAM, J. W., 1879: **Roraima and British Guiana,** pp. 363 (London). — Many botanical notes. The same author's "Across Central America", pp. 353 (London 1877) has fewer natural history notes.

BOUILLENNE, R., 1930: **Un Voyage Botanique dans les Bas-Amazones,** pp. 185 (Arch. Inst. Bot. Liège 8, nr. 3). —Illustrated account of a Belgian expedition (J. MASSART, P. BRIEN, P. LEDOUX, A. NAVEZ et R. BOUILLENNE).

BROUSSEAU, G., 1901: **Les Richesses de la Guyane Française, et de l'ancien contesté franco-brésilien. Onze ans d'exploration,** pp. 248 (Paris). — Not primarily botanical, but one of the few books of interest from our point of view on French Guiana. Rare.

BÜRGER, O., 1923: **Reisen eines Naturforschers im Tropischen Amerika,** 2 vols. in one, ed. 3, pp. 224 + 222 (Leipzig). — I, **Zum westindischen Mittelmeer, auf dem Magdalena, Streifzüge in den Kordilleren;** II, **Durch die Llanos, auf Meta und Orinoco, Trinidad und die Grenadinen.** — This is, for the botanist, the most interesting of the author's numerous books.

BURMEISTER, H., 1861: **Reise durch die La Plata-Staaten, mit besonderer Rücksicht auf die physische Beschaffenheit und den Culturzustand der Argentinischen Republik,** 2 vols., pp. 504 + 540. — Somewhat lengthy. The author was a zoologist from Halle who also collected plants.

CALVERT, A. S. and P. P., 1917: **A Year of Costa Rican Natural History,** pp. 577 (New York). — An extensive volume of zoological, botanical and general impressions and notes.

CAPPELLE, H. VAN, 1906: **Au Travers des Forêts Vierges de la Guyane Hollandaise,** pp. 198 (Baarn et Paris). — Many photographs.

CHAMPLAIN, S. [1859]: **Narrative of a Voyage to the West Indies and Mexico in the years 1599-1602 . . . ,** translated from the original and unpublished manuscript, with a biographical notice and notes by ALICE WILMERE, edited by NORTON SHAW, pp. 48 (London: Hakluyt Soc.). — Interesting account of an expedition made about 1601, "exhibiting the state of some of the West Indies Islands nearly 350 years ago, many of them being then uninhabited by Europeans".

CHAPMAN, F. M., 1938: **Life in an Air Castle,** pp. 250 (New York).— Deals chiefly with the Barro Colorado Biological Station in Gatun Lake, Canal Zone.

DARWIN, C. R., 1839 (etc.): **Journal and Remarks** *in* **Narrative of the Surveying Voyages of . . . Adventure and Beagle between . . . 1826 and 1836,** Vol. 3. — Later editions have other titles, *e.g.* 1872 (etc.): Journal of Researches into the Natural History and Geology of the Countries visited during the Voyage of H.M.S. Beagle round the World . . . , pp. 519 (New York, etc.). About half of this classic reports on travels and exploration in South America, the Galapagos, etc. Most of the facts related concern zoology and geology rather than botany*.

DETMER, W., 1897: **Botanische Wanderungen in Brasilien,** pp. 188 (Leipzig). — Travel impressions of a famous German plant physiologist ("Nun habe ich die wundersame Tropenwelt gesehen, und darf die Bereicherung, welche meine Anschauungen sowie Kenntnisse durch die Reise erfahren haben, als nicht unerheblich bezeichnen").

DOFLEIN, F., 1900: **Von den Antillen zum fernen Westen. Reiseskizzen eines Naturforschers,** pp. 180 (Jena). — Pp. 3-87 deal with the West Indies. The author was a well-known zoologist, but the book is of a very general interest.

DOMIN, K., 1927/29: **Travels in the West Indies,** 2 vols., in Czech (Prague).

FOSTER, M. and R., 1945: **Air Gardens of Brazil,** *in press* (Lancaster, Pa.). — Excursions to collect bromeliads, orchids, etc. Will contain much of a botanical and horticultural interest.

GADOW, H., 1908: **Through Southern Mexico . . . ,** pp. 527 (London). — An extremely readable account, based upon two journeys through S. Mexico during the months of June and September of the years 1902 and 1904.

GARDNER, G., 1846: **Travels in the Interior of Brazil,** pp. 562 (London). — Botanical travels in the Northern provinces and the gold and diamond districts (1836/41). "The climate agreed better with my health than that of England; and the country is beautiful, and richer than any other in the world . . . ."

GATES, R. R., 1927: **A Botanist in the Amazon Valley,** pp. 203 (London). — A recent, very fine botanical travelogue, also zoological and genetical observations.

GILL, R. C., 1940: **White Water and Black Magic,** pp. 369 (New York). — A verbal cotillon, chiefly concerned with trips searching for data about curare in Ecuador.

GOODSPEED, T. H., 1941: **Plant Hunters in the Andes,** pp. 429. — Amongst the best of modern travel accounts, informative, readable without being too popular; very fine photographs. Deals chiefly with Peru and Chile.

GRIEVE, S., 1906: **Notes upon the Island of Dominica . . . ,** pp. 126 (London). — Account of an expedition to study the flora and fauna of the island of Dominica, also much general information.

GUENTHER, K., 1931: **A Naturalist in Brazil, The Record of a Year's Observation of her Flora, her Fauna, and her People,** pp. 400 (Boston). — Translated from the German by B. MIALL (the German ed. is not often met with). One of the best general biological, modern travel accounts.

GÜSSFELD, P., 1888: **Reise in den Andes von Chile und Argentinien . . . ,** pp. 480 (Berlin). — Plants identified by ASCHERSON.

HAGEN, V. W. VON, 1940: **Jungle in the Clouds,** pp. 260 (New York). — Expedition to

* The original diary of DARWIN's voyage on the *Beagle,* edited by his granddaughter, NORA BARLOW, was published a few years ago (New York, 1934).

the rain forests of Honduras. The same author wrote several other travel books, which contain material of a botanical interest ("Ecuador the Unknown", 1939, etc.). Of interest are also his accounts of native paper industry. A popular book on the development of natural history in Latin America by him is in press ("South America called them", N.Y.: Knopf).

HENDERSON, J. B., 1916: **The Cruise of the Tomas Barrera . . .**, pp. 320 (New York).— Narrative of a scientific expedition to Western Cuba and the Colorado reefs with observations on geology, fauna and flora.

HERZOG, TH., reported in 2 volumes on his explorations in South America: **Bergfahrten in Südamerika**, pp. 212 (Stuttgart, 1925) and **Vom Urwald zu den Gletschern der Kordillere**, ed. 2, pp. 240 (Stuttgart, 1923).

HIGGINS, H. H., 1887: **Notes by a Field-Naturalist in the Western Tropics . . .**, pp. 205 (Liverpool).— Journal kept on board the Royal Mersey Steam Yacht "Argo".

HINGSTON, R. W. G., 1932: **Naturalist in the Guiana Forest** (London).— Account of an Oxford University Expedition. Much entomology.

HUDSON, W. H., a British ornithologist and naturalist, who spent most of his life in Argentina, wrote many popular accounts of his rambles of which his **The Naturalist in La Plata** (London, 1892, etc.) and **Idle Days in Patagonia** (London, 1893, etc.) are the best known. Too popular for most of us.

HUMBOLDT, A. VON.— **Personal Narrative of Travels to the Equinoctial Regions of America, during the years 1799-1804** by ALEXANDER VON HUMBOLDT and AIMÉ BONPLAND.— Of this classic there exist numerous editions in many languages. THOMASINA ROSS' edition (London 1900, 3 vols.) is very handy and has a good index. VON HUMBOLDT'S original and extensive *Voyage . . .* was issued in Paris in the years 1805-1834 in 23 volumes. Sections of these have been reprinted at various times and in several languages. There exist many biographies of HUMBOLDT. Most useful is perhaps K. BRUHNS' Life of Humboldt (Boston, 1873, 2 vols.). This is of course no longer up-to-date. There is really a need for a modern critical biography of VON HUMBOLDT. There exist several biographies in Spanish which are of interest in some way or another (*e.g.* VITO ALESSIO ROBLES 1940: ALEJANDRO DE HUMBOLDT: Su Vida y Su Obra; Mexico).

JONES, R. W., 1943: **A Journey to the First International Orchid Congress and Orchid Collecting in Mexico, I-IV** (Am. Orchid Soc. Bull., June 1, 1943, *seq.*).— A recent account of special interest to North American collectors planning to visit Mexico. For a somewhat similiar account on Costa Rica, *see* W. KUPPER 1939, Austral. Orchid Rev. 4:12 *seq.* (1939).

KELLER, F., 1874 (etc.): **The Amazon and Madeira Rivers**, pp. 177 (New York, etc.).— A travel of exploration, made around 1868, with many botanical and agricultural notes; beautiful woodcuts (plates 25 and 26).

LA CONDAMINE, C. M. DE, 1745 (etc.): **Relation abrégée d'un voyage fait dans l'intérieur de l'Amérique Méridionale, depuis la Côte de la Mer du Sud, jusq'aux Côtes du Brésil & de la Guyane, en descendant la rivière des Amazones . . .**, pp. 379 (Paris, etc.).— A fascinating early account.

LOEFLING, P., 1766: **Reise nach den spanischen Ländern in Europa und America in den Jahren 1751-1756** (Berlin).— A simple, posthumous account by one of LINNÉ's best students ("LOEFLING opferte sich auf für Floren und deren Liebhaber die Ihn vermissen"), translated from the Swedish.

LUMHOLTZ, C., 1902: **Unknown Mexico, A Record of Five Years' Exploration among the Tribes of the Western Sierra Madre: in the Tierra Caliente of Tepic and Jalisco; and among the Tarascos of Michoacan**, 2 vols., pp. 530 + 496.— Many books chiefly dealing with archaeology and anthropology are not too interesting for most biologists. Every biologist, however, will enjoy this fine, beautifully illustrated work. Like most of LUMHOLTZ' writings, it has much of a general and plant science interest.

LUMHOLTZ, C., 1912: **New Trails in Mexico; an account of one year's exploration in North-western Sonora, Mexico, and South-western Arizona, 1909-1910**, pp. 411 (London).

MACDONALD, N., 1940: **The Orchid Hunters . . .**, pp. 282 (London, etc.).— The best of several modern books of this type, though less interesting than MILLICAN's "Travels".

MARIE-VICTORIN, le Frère et le Frère LÉON 1942 & 1944: **Itinéraires Botaniques dans l'Ile de Cuba**, 2 vols., pp. 496 + 410 (Montréal: Contrib. Inst. Bot. Univ., No. 41 & 50).—With a large number of excellent photographs. Brother MARIE-VICTORIN was killed in an automobile accident in July, 1944. For a complete biography of this great and interesting figure *see* L. P. AUDET 1942, Le Frère Marie-Victorin, pp. 283 (Québec: Les Éditions de l'Érable).

MAXIMILIAN, Prinz zu WIED-NEUWIED, 1819 (etc.): **Reise nach Brasilien**, 2 vols., pp. 380 + 345 + atlas.— A classical travel account with beautiful illustrations, *cf.* plates 9*a* and 12*a*.

MEXIA, Y., 1929: **Botanical Trails in Old Mexico; the lure of the unknown** (Madroño 1: 227-238).— This active collector wrote several short interesting reports, *cf.* CHRON. 5:115 (1939).

MEYER, H., 1907: **In den Hochanden von Ecuador . . .**, pp. 551 + atlas (Berlin).— A most desirable work, beautiful plates. For a shorter account see the same author's (1925) "Hochtouren im tropischen Amerika" (Leipzig: Brockhaus: Reisen und Abenteuer, Vol. 32).

MILLICAN, A., 1891: **Travels and Adventures of an Orchid Hunter**, pp. 222 (London).— A classical account of an orchid collector's odyssey, in the Northern Andes. There exist numerous books of this type, several of them with erroneous and exaggerated statements, which make them of little interest from our point of view. MILLICAN's account is reliable and has numerous nice illustrations.

MOLINA, J. I., 1782 (etc.): **Saggio sulla Storia Naturale del Chili**, pp. 368 (Bologna).— A most important work, of which there exist several editions and translations. *Cf.* LOOSER 1941, CHRON. 6:250.

**Mutis, J. C.:** —
VEZGA, FLORENTINO, 1936: La Expedición Botánica, pp. 212 (Bogotá: Editorial Minerva) (P. 15 *seq.*, chiefly on MUTIS' explorations and work; pp. 166-192, "La Botánica desde 1816 hasta 1859"). — For a more detailed account of MUTIS' work *cf.* DIEGO MENDOZA 1909: Expedición Botánica de JOSÉ CELESTINO MUTIS al Nuevo Reino de Granada y Memorias Inéditas de FRANCISCO JOSÉ DE CALDAS, pp. 297 (Madrid) and GREDILLA, A. F., 1911: Biografía de José C . . . MUTIS con la Relación de su viaje y estudios practicados en el Nuevo Reino de Granada reunidos y anotados . . ., pp. 713 Madrid) (Most critical and extensive).

ØRSTED, A. S., 1857: **Jamaica, En Naturskildring** (Copenhagen; a collection of reprints from "Tidsskrift for pop. Fremstillinger"). — ØRSTED visited Jamaica in 1846. His account in simple Danish, is very interesting, also on account of the illustrations and the two early vegetation maps (our plate 3 has been reproduced from this booklet).

PHILIPPI, R. A., 1860: **Reise durch die Wueste Atacama,** pp. 192 + 62 (Halle). — R. A. PHILIPPI traveled widely over a long period in Chile, and wrote many interesting travel accounts (most of them short), in *Bot. Zeitung,* etc.: *cf.* his bibliography in *Leopoldina* 42:59-66 (1906).

PIM, B. and B. SEEMANN, 1869: **Dottings on the Roadside in Panama, Nicaragua and Mosquito,** pp. 468 (London). — Of SEEMANN's writings on Central America this is of the most general interest.

POEPPIG, E., 1835 (etc.): **Reise in Chile, Peru und auf dem Amazonenstrom während der Jahre 1827-1832,** 2 vols., pp. 466 + 464 + atlas. — A very readable account by the well-known and active collector. Of POEPPIG's first volume there exists a nice edition in one volume, prepared by W. DRASCHER ("Im Schatten der Cordillera", Stuttgart 1927), with good reproductions of several of POEPPIG's plates.

POHL, J. E., 1832/37: **Reise im Innern von Brasilien,** 2 vols., pp. 448 + 641 + atlas. — A classic, somewhat extensive account with many notes on the natural history. POHL collected extensively in Brazil.

PREUSS, P., 1901: **Nach Zentral- und Südamerika,** pp. 452 (Berlin). — Extremely interesting account by a most intelligent observer; deals in an unusual way both with agriculture and botany.

PRICHARD, H. H., 1902: **Through the Heart of Patagonia,** pp. 346 (London: Heinemann). — Well illustrated. Several natural history notes. P. 336-339, List of Plants (by JAMES BRITTEN).

PROVANCHER, l'Abbé L., 1890: **Une Excursion aux Climats Tropicaux, Voyage aux Iles-du-Vent . . .,** pp. 359 (Québec). — "Vingt fois en lisant des voyages de naturalistes, tels que ceux de DARWIN, de HUMBOLT, d'AGASSIZ et d'autres, j'avaix en imagination savouré leurs jouissances, et, aux détails de leurs narrations, rêvé de voir de mes yeux les phénomènes et les spectacles dont la seule description me captivait si fortement . . .".

RITTER, K., 1836: **Naturhistorische Reise nach der westindischen Insel Hayti . . .,** pp. 206 (Stuttgart). — Account of a trip made in 1820 by the famous author of "Allgemeine Erdkunde" ('multa insunt ad historiam et geographiam plant. cult. spectantia', PRITZEL).

ROBESON, G. M., 1874: **Reports of Explorations and Surveys for the Location of a Ship-Canal between the Atlantic and Pacific Oceans, through Nicaragua, 1872-73** (Washington).

RODWAY, J., 1894: **In the Guiana Forest,** pp. 242 (London). — With a very strong emphasis on problems of evolution ("Studies of Nature in relation to the struggle for Life"; introduction by GRANT ALLEN).

**Ruiz and Pavón's Expedition** (*cf.* p. 39): — HIPÓLITO RUIZ' account of his expedition, discovered some years ago in Spain, was published in Spanish, with extensive notes, by Father AGUSTÍN JESÚS BARREIRO in 1931. Of this there exists a careful translation (easily available) by D. E. DAHLGREN (Botan. Series, Field Museum of N. H., Vol. 21, Publ. 467, pp. 372).

RUSBY, H. H., 1933: **Jungle Memories,** pp. 388 (New York). — Travels of a former professor of pharmacognosy of Columbia University, a most active collector.

SACHS, CARL, 1879: **Aus den Llanos; Schilderung einer naturwissenschaftlichen Reise nach Venezuela,** pp. 369 (Leipzig). — Chiefly zoological.

SACK, Baron ALBERT VON, 1821: **Beschreibung einer Reise nach Surinam und des Aufenthaltes daselbst in den Jahren 1805, 1806, 1808 . . .,** 2 vols., pp. 240 + 185 (Berlin).

**Saint-Hilaire, A. F. C. Prouvençal de:** —
AUGUSTE DE SAINT-HILAIRE, who traveled widely in Brazil, wrote several travel accounts, of some of which there exist different editions. The principal ones are his **Voyages dans l'Intérieur du Brésil,** I-IV: —
1830 (etc.): **Voyage dans les Provinces de Rio de Janeiro et de Minas Geraes,** 2 vols., pp. 458 + 478 (Paris).
1833 (etc.): **Voyage dans le District des Diamans et sur le Littoral du Brésil . . .,** 2 vols., pp. 403 + 456 (Paris).
1847/48 (etc.): **Voyage aux Sources du Rio de S. Francisco et dans la Province de Goyaz.**
1851 (etc.): **Voyage dans les Provinces de Saint-Paul et de Sainte-Catherine,** 2 vols., pp. 404 + 423 (Paris).
After the author's death R. DE DREUZY edited his **Voyage à Rio Grande do Sul,** pp. 644 (Orléans).
A more concise edition of the above five works will be found in the author's "Voyage dans l'Intérieur du Brésil", 2 small vols., pp. 212 + 208 (1850). — From a purely botanical point of view the short résumé which DE SAINT-HILAIRE published in 1824 in his "Histoire des Plantes les plus remarquables du Brésil et du Paraguay" under the title of "Esquisse des Voyages de l'Auteur, considérés principalement sous le rapport de la Botanique" is useful. This is being reprinted at present and will be published, with a foreword and biographical sketch by Dr. A. E. JENKINS, route map, etc., in Chronica Botanica, vol. 9 (1945). Single copies will be available at $2.50.

The following cheap Brazilian translations in the serial 'Brasiliana' Serie 5*a*, Bibl. Pedag. Brasil., should also be mentioned: 5, Segunda viagem do Rio de Janeiro a Minas Geraes . . .; 58, Viagem á Provincia de Santa Catharina (1820) . . .; 68 & 78, Viagem ás Nascentes do Rio São Francisco . . . (with notes by C. Ribeiro de Lessa); 72, Segunda Viagem ao Interior do Brasil . . .; 126 & 126*a*, Viagem pelas Provincias de Rio de Janeiro e Minas Geraes (with notes by C. Ribeiro de Lessa).

Sandeman, C., 1939: **A Forgotten River,** pp. 299 (London, etc.). — Diary of a botanical trip in Peru by a British collector. One of the most typical botanical diaries known to me.

Sanderson, I. T., 1939: **Caribbean Treasure,** pp. 292 (New York). — Chiefly zoological, but of considerable general interest and very well written. Accounts of explorations in Trinidad, Haiti, Surinam.

Sapper, K., 1902: **Mittelamerikanische Reisen und Studien aus den Jahren 1888 bis 1900,** pp. 419 (Braunschweig). —Botanical, agricultural and general impressions of travels through Antigua, Honduras, Nicaragua, Costa Rica, etc.

**The Schomburgks:** —

The brothers M. R. and R. H. Schomburgk* (*cf.* p. 44/45) traveled and collected extensively in British Guiana. They left three major accounts of their explorations: —

Schomburgk, M. R., 1847/48: **Reisen in Britisch-Guiana . . . . 1840/44,** 3 vols. (Leipzig). — Most of this is descriptive zoology and botany.

Schomburgk, M. R., 1876: **Botanical Reminiscences in British Guiana,** pp. 90 (Adelaide). — Very nice, concise.

Schomburgk, R. H., 1876: Robert Hermann Schomburgk's **Reisen in Guiana und am Orinoko während der Jahre 1835-1839 nach seiner Berichten und Mittheilungen an die Geographische Gesellschaft in London** . . . mit einem Vorwort von Alexander von Humboldt . . ., pp. 510 (Leipzig). — Coloured plates.

Shufeldt, R. W., 1872: **Report of Explorations and Surveys, to ascertain the Practicability of a Ship-Canal between Atlantic and Pacific Oceans, by Way of Isthmus of Tehuantepec** (Washington). — Report on geology, natural history, etc. by John C. Spears.

Skottsberg, C., 1911: **The Wilds of Patagonia,** pp. 336 (London). — This narrative of the Swedish expedition to Patagonia, Tierra del Fuego and the Falkland Islands (1907/09) is of the relatively few purely botanical travelogues one of the very best and most inspiring.

Spix, J. B. von, und C. F. P. von Martius, 1823/31: **Reise in Brasilien . . . in . . . 1817 bis 1820 gemacht und beschrieben,** 3 vols. + atlas. — The account of the travels of the editor of the Flora Brasiliensis (*cf.* p. 301/302). A concise English translation by H. E. Lloyd was issued in 2 vols. in London in 1824. This has a few illustrations (not the folio atlas). An excerpt in Brazilian was recently published in Vol. 118 of the Bibl. Pedag. Brasil., with notes by Pirajá da Silva and Paulo Wolf.

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*Introductory Bibliographical Notes, 2:* **Selected references, supplementing various bibliographies and articles in this volume:** — This is a most heterogeneous list, consisting of a number of references of entirely different scope, non-botanical travel and guide books, various bibliographies, all kinds of non-botanical literature of a broad general interest, and then a number of additions (especially very recent publications) to the bibliographies and articles in this volume, etc.:


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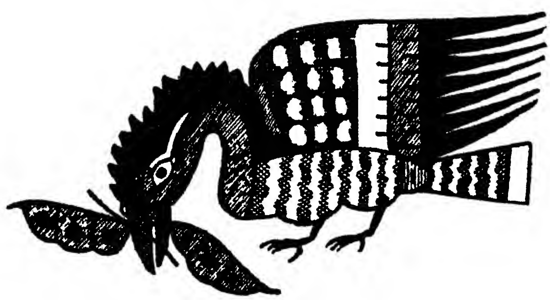
WISE, MURRAY M., *et al.*, 1941: **Latin American Periodicals Current in the Library of Congress**, preliminary ed., pp. 137 (U.S. Library of Congress, Div. of Manuscripts, Hispanic Foundation).

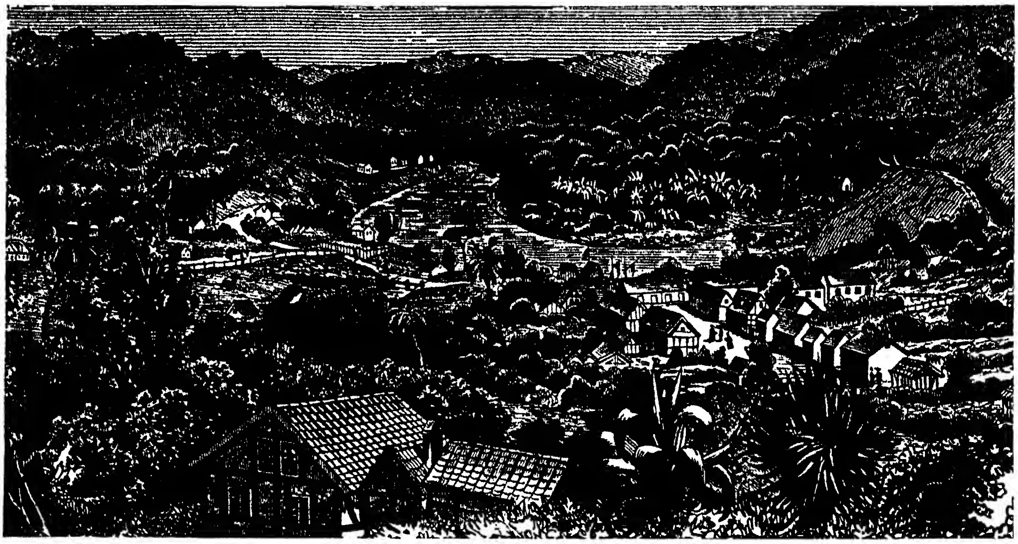
WODEHOUSE, R. P., 1942: **Hayfever in Latin America** (Chron. Bot. 7:274).

WOLF, H. and R., 1936: **Rubber, A Story of Glory and Greed** (New York).

**Young Readers**: — Several bibiographies have recently been issued of books on Latin America for children and young people. The Div. of Intellectual Coöperation of the Pan American Union issued "Books on Latin America for Young Readers". The American Library Association devoted part of their "Booklist" of April 1, 1941 to such a list (with a supplement in the May 15, 1942 issue). Of further interest are "Latin American Backgrounds" (Research Div. of the Nat. Education Association, Oct. 1940) and "A List of Books for the Children of the three Americas" (Univ. of Michigan Library Extension Service). The list prepared by NORA E. BEUST of the Library Service Div. of the U.S. Office of Education ("Our Neighbor Republics . . .", Feb. 1942) is in process of revision.

ZWEIG, S., 1938: **Magellan, Conqueror of the Seas** (New York).





FARM SCENES IN BRAZIL (MIDDLE 19TH CENTURY). — 3, A VIEW OF BLUMENAU, IN SOUTHERN BRAZIL. — *From* TSCHUDI'S "Reisen durch Südamerika".

*Introductory Bibliographical Notes, 3:* **Recent Publications of the Office of Foreign Agricultural Relations of the U. S. Department of Agriculture, relating to Latin America:** — The able staff of the Office of Foreign Agricultural Relations has done more than any other agency to promote understanding of Latin American agriculture and related problems. Although some of the following articles have been listed elsewhere in this volume, it seems useful to bring together a complete list of the recent publications of the Office. Some of the publications listed have been prepared for the general reader rather than for the specialist, and are necessarily somewhat popular.

*Regional Studies, Mexico:* —

The Land Problem in Mexico (FA*-Mar. 1939).
Cotton Production in Mexico (FS no. 65-Feb. 1940)
Mexican Vanilla Production and Trade (FA-Nov. 1941)
Agricultural Relations with Mexico (FA-Nov. 1942)
Agricultural Education in Mexico (AA-Oct. 1943)
Mexico to Develop Guano Industry (AA-Nov. 1943)
The Fruit Industry of Mexico (FAR no. 9-Apr. 1944)

*Regional Studies, Costa Rica:* —

The New Inter-American Institute (AA-Dec. 1942)
Costa Rican Dairyland (AA-Nov. 1943)
Copey Oak in Costa Rica (AA-July 1944)

*Regional Studies, El Salvador:* —

San Andrés — Agricultural Experiment Station (AA-Aug. 1943)

*Regional Studies, Guatemala:* —

Agricultural Production in Guatemala (FA-Sept. 1943)

*Regional Studies, Honduras:* —

Escuela Agrícola Panamericana (AA-Sept. 1944)

*Regional Studies, Nicaragua:* —

Nicaraguan Agriculture Looks Ahead (AA-Oct. 1943)
Dairying in Nicaragua (AA-Feb. 1944)
The Agriculture of Nicaragua (FA-Sept. 1944)

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* Abbreviations: —
AA = *Agriculture in the Americas*
FA = *Foreign Agriculture*
FAB = *Foreign Agricultural Bulletin*
FAR = *Foreign Agricultural Reports*
FS = *Foreign Service Report*

*Regional Studies, Panama:* —

Rural Society in Panama (AA-Apr. 1943)
Recent Agricultural Policy Developments in Panama (FA-Nov. 1943)

*Regional Studies, Cuba:* —

The Cuban Winter Vegetable Industry (FA-Sept. 1937)
Cuban Agriculture (FA-Feb. 1942)
The Agriculture of Cuba (FAB no. 2-Dec. 1942)
Henequen from Cuba (AA-Apr. 1944)

*Regional Studies, Haiti:* —

Agriculture in Haiti (FA-Dec. 1939)
Haiti Makes Rubber History (AA-July 1941)
Haiti's New Horizons (AA-Feb. 1943)

*Regional Studies, Jamaica:* —

The Agriculture of Jamaica (FA-Apr. 1942)

*Regional Studies, Argentina:* —

The Argentine Corn Industry (FA-Aug. 1937)
Argentine Agricultural Policy (FA-Feb. 1938)
The Argentine Wheat Industry (FA-July 1938)
The Argentine Pear Industry (FA-Jan. 1939)
The Argentine Pasture & Livestock Industry (FA-Jan. 1940)
Argentine Corn (AA-Aug. 1941)
Agriculture in the Argentine Trade Agreement (FA-Nov. 1941)
The Fruit Industry of Argentina (FAR no. 1-Jan. 1942)
Argentine Grapes and Wine Control Program (FA-Dec. 1942)

*Regional Studies, Bolivia:* —

An Economic Study of Agriculture in Bolivia (SR-Aug. 1942)
Bolivian Progress in Agricultural Expansion (FA-Dec. 1942)

*Regional Studies, Brazil:* —

Cotton Production in the State of São Paulo (FA-Jan. 1937)
The Brazilian Coffee Defense Experiment (FA-Dec. 1937)
Brazilian Agricultural Policy (FA-Feb. 1938)
Cotton Production in Southern Brazil (FS no. 63-Sept. 1939)
Cotton Production in Northeast Brazil (FS no. 64-Dec. 1939)
Production of Oiticica Oil in Brazil (FA-Oct. 1940)
Agriculture in the São Paulo Northern Paraná Region (FA-July 1941)
Research in Tropical Brazil (AA-Dec. 1941)
The Fruit Industry of Brazil (FAR no. 2-Jan. 1942)

The Amazon Basin Brazil Nut Industry (FAR no. 4-Jan. 1942)
The Prodigeous Brazil Nut (AA-Apr. 1942)
Tapioca from a Brazilian Root (AA-May 1943)
Scientific Agricultural Education in Brazil (AA-Sept. 1943)
Grasses of Brazil and Venezuela (AA-July 1944)

*Regional Studies, Chile:* —

The Fruit Industry in Chile (FAR no. 3-Jan. 1942)
The New Chilean Nitrate Industry (AA-June 1943)

*Regional Studies, Colombia:* —

The Agriculture of Colombia (FAB no. 1-Oct. 1942)

*Regional Studies, Ecuador:* —

Ecuador's Balsa Goes to War (AA-Nov. 1943)

*Regional Studies, Paraguay:* —

Paraguay Improves its Agriculture (AA-April 1944)

*Regional Studies, Peru:* —

Agriculture in Peru (FA-June 1938)
U.S-Peruvian Trade Agreement (FA-July 1942)
Tingo María (Agricultural Experiment Station) (AA-June 1943)
Wheat in Peru (AA-Dec. 1943)
Extension Work at Tingo María (AA-Feb. 1944)
Agricultural Museum in Peru (AA-Feb. 1944)
The New Flax Industry of Peru (FA-Mar. 1944)
Lagunas — Babasco Capital of the World (AA-May 1944)

*Regional Studies, Venezuela:* —

Agriculture in the Venezuelan Trade Agreement (FA-Dec. 1939)
Venezuela's Agricultural Problem (FA-June 1942)
Grasses of Brazil and Venezuela (AA-July 1944)

*Other Latin American Studies:* —

Production of Cotton in Latin America (FA-Sept. 1939)
Tobacco Trade with Latin America (FS no. 82-June 1940)
Report on the World Cotton Situation and the Possibilities of Inter-American Collaboration (SR-Jan. 1941)
World Cacao Production and Trade (FA-Feb. 1941)
Speaking of Rubber (AA-Feb. 1941)
Rubber Grows Up (AA-Mar. 1941)
The Inter-American Coffee Agreement (FA-Apr. 1941)
Rubber on the Rebound, East to West (AA-Apr. 1941)
Rubber is Coming Home (AA-May 1941)
Meet the Tonka Bean (AA-June 1941)
American Ambrosia (Certain Fruits of Latin America) (AA-July 1941)
Plants America Gave the World (AA-Sept. 1941)
The Coffee Hemisphere (AA-Oct. 1941)
Fighting the Pink Invader: Bollworm (AA-Jan. 1942)
Mate: The South American Tea (AA-Jan. 1942)
War Speeds the Rubber Project (AA-Feb. 1942)
The Story of Vanilla (AA-Feb. 1942)
Small Farm Rubber Production (AA-Mar. 1942)
Quinine from the "Fever Tree" (AA-Mar. 1942)
Accent on Sugar (AA-Apr. 1942)
Oils of Araby (AA-Apr. 1942)
America's Drug Plants (AA-May 1942)
Plant Fibers in Wartime (AA-June 1942)
Latin America's Orchards (AA-June 1942)
The Banana Circles the Globe (AA-July 1942)
Rubber from the Russian Dandelion (AA-July 1942)
Yerba Mate (FA-Aug. 1942)
Cotton Becomes a Hemisphere Problem (AA-Oct. 1942)
Erosion in the Americas (AA-Oct. 1942)
Sponges from a Vine (AA-Nov. 1942)
Indian Farming in South America (AA-Dec. 1942)
The Technique of Plant Exchange (AA-Jan. 1943)
More Rubber from Castilla (AA-Jan. 1943)
The Future of the Forests (AA-Jan. 1943)
Quebracho Makes Shoes (AA-Apr. 1943)
Tapioca from a Brazilian Root (AA-May 1943)
Soil Conservation in South America (AA-July 1943)
Quinine from Seed (AA-July 1943)
Papaine: To Make Meat Tender (AA-July 1943)
Divi-Divi Offers Tannin (AA-Aug. 1943)
The Americas Look to their Rice Fields (AA-Sept. 1943)
Consider the Forests of Tropical America (AA-Oct. 1943)
Babassú — A Hard Nut to Crack (AA-Oct. 1943)
Pest Control Challenges the Americas (AA-Nov. 1943)
America — Home of the Bean (AA-Dec. 1943)
Agriculture Across the Andes (AA-Jan. 1944)
Abacú — A New Crop for Latin America (AA-Jan. 1944)
Wildlife Management in the Americas (AA-Jan. 1944)
Soft Fiber from Roselle (AA-Feb. 1944)
Pearl Harbor Sent Quinine Home (AA-Mar. 1944)
Hacienda Pichilingue in Ecuador (AA-Mar. 1944)
Flowers that Fight Malaria (AA-Apr. 1944)
Naranjillas — Golden Fruit of the Andes (AA-June 1944)
Latin America Produces More Rice (AA-Aug. 1944)
Canal Zone Experiment Gardens (AA-Aug. 1944)
Science's Fight for Healthy Hevea (AA-Aug. 1944)
The River Basins of Latin America (AA-Sept. 1944)

*Agricultural Education:* —

New Education in Tropical America (AA-Nov. 1942)
Agricultural Extension in the Americas (AA-Feb. 1943)
Education in Haiti (AA-Aug. 1943)
Scientific Agricultural Education in Brazil (AA-Sept. 1943)
Agricultural Education in Mexico (AA-Oct. 1943)
Toward Practical Coöperation (AA-June 1944)
Escuela Agrícola Panamericana (AA-Sept. 1944)

*"Gifts to the Americas":* —

The Potato (AA-May 1943)
Chewing Gum (AA-June 1943)
Maize (AA-July 1943)
Balsa Wood (AA-Aug. 1943)
The Chinchilla (AA-Sept. 1943)
The Peanut (AA-Oct. 1943)
Tobacco (AA-Nov. 1943)
Tomato (AA-Dec. 1943)
The Pineapple (AA-Feb. 1944)
Kapok (AA-Mar. 1944)
The Cashew (AA-Apr. 1944)
Ipecac (AA-July 1944)
Mahogany (AA-Aug. 1944)

*Economic Plants of Interest to the Americas:* —

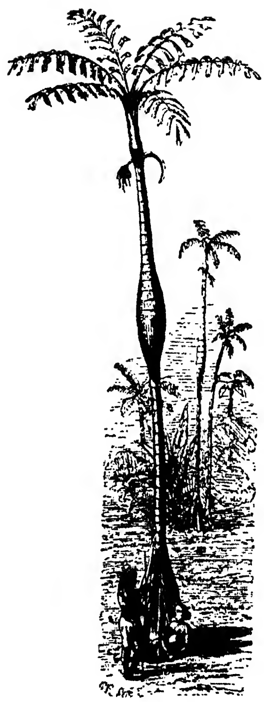
Names of Crop Plants Used in the Americas (SR-June 1943)
Cassia and Cinnamon (SR-July 1943)
Wattle Bark (SR-Aug. 1943)
Rotenone (SR-Aug. 1943)
Leguminous Shrubs and Trees Used as Shade (SR-Aug. 1943)
Oiticica and Chia Oils (SR-Aug. 1943)
Kenaf as a Fiber Crop (SR-Oct. 1943)
Roselle as a Fiber Crop (SR-Dec. 1943)
Grasses Producing Essential Oils (SR-Apr. 1944)

*Experiment Stations:* —

The New Inter-American Institute (AA-Dec. 1942)
San Andres Experiment Stations (El Salvador) (AA-Aug. 1943)
Hacienda Pichilingue (Ecuador) (AA-Mar. 1944)
Tingo María (Peru) (AA-June 1943)
The Canal Zone Experiment Gardens (AA-Aug. 1944)

*International Collaboration:* —

Inter-American Agricultural Coöperation (FA-May 1940)
World War, Hemisphere Trade and the American Farmer (FA-Jan. 1941)
Can the Americas Live Alone (AA-Feb. 1941)
Agriculture's Rôle in Hemisphere Defense (FA-Mar. 1941)
Foods the Americas Buy and Sell (AA-Aug. 1941)
Resolutions of Second Inter-American Conference of Agriculture (SR-July 1942)
A Land Policy for the Americas (AA-Mar. 1943)
What Shall the Americas Grow (AA-May 1943)



# PARS I

THIS, THE FIRST PART OF "PLANTS AND PLANT SCIENCE IN LATIN AMERICA," CONSISTS PRIMARILY OF ARTICLES NOT PREVIOUSLY PUBLISHED. ONLY A FEW OF THE ARTICLES IN THIS PART HAVE BEEN PUBLISHED IN CHRONICA BOTANICA. THESE HAVE, IN THE MEANTIME, BEEN REVISED BY THE AUTHORS. — *For a complete and detailed table of contents, and index of names see pp. 350, seq.*

PLATE 4. — "PLANTS AND BIRDS OF SURINAM." — Composition by a self-taught mulatto (ca 1811), from SACK's "Reise nach Surinam" (1821, cf. p. xviii-xix). — *Courtesy Arnold Arboretum of Harvard University.*

Wilson Popenoe: **Some Problems of Tropical American Agriculture:** — Tropical agriculture presents some striking contrasts to that of temperate regions. The lack of freezing temperatures (except at high altitudes) means that there may be an almost unbroken cycle of activity in the soil, as well as opportunity for many insect pests and plant diseases to multiply without ceasing from one year's end to another. It also means the absence of winter chilling, necessary to complete the rest period of many crop plants native to the temperate zone. Relative uniformity in length of day reduces the effects of long days and short days which are a feature of temperate zone agriculture. Excessive rainfall, including downpours which sometimes involve a precipitation of 24 inches in 24 hours, has far-reaching results upon the soil. One can go badly astray in judging the fertility of tropical soils under luxuriant forest cover — soils which, when denuded of forest and planted to annual crops, soon require abundant use of fertilizers. In this connection, the primitive practice of clearing the land, taking off a single crop of corn, then allowing second-growth forest to develop, with a view to shading out grass and restoring the physical condition of the soil, is of great interest and significance.

In considering these and other features of tropical American agriculture it is essential to remember that we do not have, in many instances, the extensive background of investigation and experimentation upon which have been built the great agricultural industries of the United States, of Europe, and of the temperate parts of South America. Nor do we have the background possessed by many of the agricultural industries of the Asiatic tropics. With regard to the technical aspects of crop production in general, it must be admitted that the American tropics are today where Europe and the United States were fifty years ago.

The development of tropical American agriculture, in its broader aspects, must necessarily be a slow process, beginning with the simpler things and working gradually toward the refinements. This seems sometimes to be overlooked by highly-trained technical workers from the temperate zone, with the result that there has been — and probably will continue to be — much disappointment and wasted effort. The average agriculturist of tropical America is not prepared to put into effect, over night as it were, even those techniques of other regions which obviously could be applied to his conditions without previous experimentation.

Until we attain a better understanding of tropical problems it is necessary to bear in mind that we must learn to walk before we can run. To cite an example: it is useless to attempt, in any given region, the development of a sound agriculture until we know in a general way the soils of that region and their adaptability to the crops we desire to grow. Later can, and must, come more intensive investigation of the soil and its special local problems.

Likewise, it is useless to attempt the refinements of fruit culture so long as vegetative propagation is the exception rather than the rule. Even the citrus fruits are propagated more frequently in the tropics by seed than by graftage.

*CLIMATOLOGY:* — Particularly in the tropics it seems desirable to have some convenient method of expressing differences in altitude, wherever these are sufficiently great to result in significant differences in maximum and minimum temperatures. In Spanish-speaking countries it has long been the custom to distinguish between the relatively hot lowlands (*tierra caliente*); the regions of moderate elevation where citrus fruits thrive but the coconut palm disappears (*tierra templada*); and the highlands (*tierra fria*) where frosts occur and where many products of the temperate zone can be cultivated — wheat, barley, apples and pears, for example.

As recently pointed out by the erudite Henri Pittier, it is a mistake to refer to these as *zones,* since the term zone is properly applied only to geographic or latitudinal divisions. He recommends the use of the word *belt* instead of *zone;* but the Spanish terminology seems adequate from the agricultural standpoint and has in its favor widespread usage throughout the intertropical regions of America.

It is in any case highly desirable to avoid the confusion which arises when climates of regions within the tropics are referred to as tropical, subtropical, and temperate: these are definitely latitudinal concepts from which the climates of tropical regions differ because (1) they have much narrower ranges of temperature, both diurnal and annual, and (2) they have narrower ranges in length of day, due to latitude.

While the altitudinal limits of *tierra caliente, tierra templada* and *tierra fria* vary with latitude, with prevailing winds, with the presence of mountain barriers, and with other factors, in general the range is about the following:

| | |
|---|---|
| Tierra caliente | sea level to 3000 feet |
| Tierra templada | 3000 to 6000 feet |
| Tierra fria | 6000 feet to the upper limit of cultivation. |

In countries such as Mexico, Guatemala, and the Andean republics, agriculture is practiced from sea level to elevations of more than 10,000 feet. Abundance of mountain barriers, the presence of isolated valleys at varying elevations, and other features result in abrupt changes of climate, literally from mile to mile. On the Pacific coast of Guatemala, for example, rainfall a few miles from the surf may be no more than 30 inches per annum. Fifteen miles inland, still practically at sea level, it may be 60 inches. Ten miles farther toward the mountains, at 1,000 feet elevation, it may be 80 inches. And then, as one begins to ascend the volcanic range, it may increase in four or five horizontal miles to as much as 150 inches, only to fall off once more above elevations of 5,000 or 6,000 feet.

Meteorological data are essential to the development of a sound agriculture. These are the tools with which technical meteorologists must work. Every effort should be made to encourage the accumulation of these data in all regions; and in so doing, it is well to keep in mind the practical objectives above all else. Where delicate instruments are installed, they must be in the hands of trained observers. Much money has been wasted by placing elaborate meteorological equipment in the hands of tropical workers not prepared to keep accurate records nor to care for the instruments. At the start, it would be better in most cases to use whatever monies are available to buy a large number of rain gauges and maximum-minimum thermometers, rather than a small number of elaborate outfits.

Only those who have worked in tropical America can fully appreciate what it means, in undertaking the agricultural development of a new region — especially if the region be one in which irrigation is to be practiced — to be faced with a complete lack of rainfall records. The subject assumes even greater importance when we reflect that enormously increased use of irrigation seems to be immediately ahead of us in many parts of the area we are considering. It is one of the next big steps forward.

*SOILS:* — Few advances have been made in tropical American agriculture during the past quarter of a century which have had such far-reaching effects, such tremendous practical value, as the use of soil surveys. One has only to cite, as the classic example, BENNETT and ALLISON'S "Soils of Cuba," a work used not only by technical men throughout the island, but by practical agriculturists as well.

There is need for a vast amount of similar work. It is, unfortunately, a task which involves a large amount of drudgery and which, to some investigators, does not have the appeal of laboratory research. But, as has already been stated, soil surveys and land classification are an essential preliminary to intelligent agricultural development of the tropics.

Cuba and Puerto Rico have received much attention from this angle. In the British West Indies, F. HARDY and his associates have done notable work. In Central America, Colombia, Ecuador and a few other regions, OSCAR MAGISTAD, GEORGE SCARSETH, the VOLK brothers, V. C. DUNLAP, W. W. PATE, S. L. WORLEY and others have soil-mapped extensive areas for the United Fruit Company.

In recent years a keen interest in this field has developed among Latin-American workers, who are receiving active coöperation and assistance from the U. S. Department of Agriculture, the Imperial College of Tropical Agriculture, the Florida Soil Science Society, and numerous agencies in their own countries.

The keynote to profitable work of this sort is simplicity. The use of simple criteria applicable in the field is the practical procedure. These, coupled with observations regarding crop behavior, will give the agriculturist a highly useful basis on which to plan his program, as has been amply demonstrated in the banana industry.

Little additional effort is required to supplement field classifications with *p*H values, determined roughly on the ground by means of Soiltex or other simple equipment; and it is obvious that this adds greatly to the value of the work.

*SOIL MANAGEMENT:* — Great confusion still exists, in the minds of agriculturists generally, with regard to the place of tillage in the tropical program. This is not true everywhere: for example in Jamaica, fifty years' experience on the south (dry) side of the island has convinced banana growers that frequent cultivation with disk harrows and an occasional plowing are essential to good production. But when the same program was tried experimentally in the moist Central American lowlands, it was abandoned after a few years as undesirable.*

The use of planted cover crops, widely practiced in the Asiatic tropics, has not yet become general in tropical America. Grass, the great enemy of tropical cultivations, is sometimes controlled by shade, as in Central American banana farms, sometimes by abandoning the land temporarily and letting the work be done gradually through the development of "bush" or second growth.

Lacking an abundance of animal manures, the use of chemical manures or fertilizers is becoming more and more important. The sugar industry, especially in Puerto Rico, has employed these extensively for some time. During the past fifteen years they have become an important factor in banana growing. Coffee planters in certain regions are coming to rely upon them.

The question has been, and still is: What kind and how much? In most cases this can only be answered through carefully planned field trials continued over a period of years. Fertilizer manufacturers have in some instances taken advantage of the situation to recommend and sell "complete" fertilizers, which were certain to get results because they contained most of the elements any crop might need on almost any soil; but the farmer has often paid for nitrogen, phosphorous and potash when he needed only nitrogen. Unfortunately the farmer cannot get the answer he wants by sending a

* The following comment has been offered by ROBERT L. PENDLETON, who has kindly reviewed the MS of this paper: "The change which has been coming over tropical agriculture in the Orient may well forecast a change to be expected in this hemisphere. This is the increasing realization of the importance of forestry or silvicultural methods as normal in the humid tropics, instead of the clean culture, horticultural or orchard methods on which we were raised in California. These latter were the pattern, more or less, on which European planters in the Far East started out to raise tea, rubber, and other crops."

soil sample to the laboratory and asking the question: "What fertilizer should I use to grow tomatoes on my land?"

*MAJOR CROPS:* — *Sugar Cane.* — Partly because of its great importance to many countries; partly because its very existence has been threatened at times by such things as mosaic disease and difficult economic situations; and partly because it has been largely in the hands of companies with the intelligence and the foresight to insist upon and support the necessary investigational work, the sugar industry stands out as the brightest example of the application of well-organized and continuous research to agriculture in the American tropics.

The early efforts of the British in the West Indies; of F. S. EARLE and his associates in Puerto Rico; of the Tropical Plant Research Foundation under W. A. ORTON and D. L. VAN DINE in Cuba; and the more recent labors of E. W. BRANDES and his associates under the aegis of the U. S. Department of Agriculture — these and many other activities are notable. The intensive agricultural practices — careful examination of soils before planting, selection of varieties, intelligent irrigation, suitable tillage, and fertilization — such as are now current in Puerto Rico, Jamaica, and elsewhere, point the way toward sound agricultural progress with many other tropical crops.

*Maize (corn).* — Throughout large areas this is the most important item in the dietary of the common people. An investigation made some years ago in Yucatán, for example, showed that in parts of that peninsula *Zea mays* provides no less than 85% of the food consumed.

Investigators have stressed the low yields obtained in many regions, especially those where the soils have become "tired" through continued cropping during many centuries. In places such as the highlands of Guatemala and Mexico, where Indian population is dense, improvement of the soil through addition of organic matter presents many difficulties; but it is the expressed opinion of J. H. KEMPTON that an increased yield of as much as 30% might be obtained through the application of simple methods of seed selection.

The significant and hopeful feature of the situation is this: corn is the most important food-crop of a large portion of the American tropics, yet it has received practically no attention, to date, at the hands of scientific agriculturists. The Indians themselves have done an outstanding job — perhaps the most notable achievement in the history of American agriculture — in the development of varieties adapted to a wide range of climatic conditions. It now remains to increase production per unit area, not only through simple selection (and eventually more elaborate techniques of plant breeding) but also, where feasible, through better methods of soil management.

*Coffee.* — This, the leading export crop of several countries, has a history almost unique in agriculture. Where else can we find an important crop which has been cultivated for more than a century, the very existence of which has never been threatened by disease or insect pests? Sugar cane has had its mosaic; cacao production has been more than halved in several countries by *Marasmius* and *Monilia;* and the entire banana industry had to be reorganized a few years ago because of the introduction of Sigatoka disease into the American tropics.

This is not saying that the coffee plant has no enemies. But it is true that coffee growers in tropical America have been able to proceed from year to year, from decade to decade, without devoting major attention to pest control. Perhaps it has been good luck more than anything else; and the day may come when the industry will be faced by a crisis such as those which overtook the others just mentioned. Let us hope that the day may be far distant.*

In the meantime, coffee culture, if it is to develop into a sound agricultural industry in which the intelligent, industrious grower receives a premium for his effort, must receive the same sort of intensive improvement which has characterised the sugar industry and the banana business. It seems likely that the biggest step forward will be in the field of vegetative propagation. We have little or no information regarding the superiority of one seedling over another, with respect to growth, fruitfulness, and other characteristics. If an investigation such as that which has been carried out in the cacao plantations of Trinidad should demonstrate that vegetative propagation of superior individuals results in greater profits to the grower the gradual rebuilding of the industry on that basis can be only a matter of time.

If vegetative propagation becomes a reality, there will be increased need for more intensive agricultural practices to take full advantage of superior and more expensive planting material. The pruning of the coffee plant, for example, is still ignored completely in some regions. In others, there are definite techniques. Further study, and widespread application of sound principles adapted to local conditions, are required.

In several countries, there is a recently-developed interest in the control of erosion on hillside plantings, and in the use of commercial fertilizers. Such interests are by no means universal, but these practices, even though still limited in extent, are straws which show the way the wind is blowing, and which augur well for the future of the coffee industry.

*Cacao.* — During four hundred years following the Discovery, tropical America, where the tree is indigenous, was the source of the world's chocolate. Then the development of cacao production in Africa and the ravages of disease in tropical America, changed materially the picture. Ecuador, for example, which exported more than a million hundredweight of cacao beans in 1916, could only ship one-fourth this amount in 1940 — due largely to the spread of two diseases, Witches' Broom (*Marasmius perniciosus*) and *Monilia* pod rot.

For more than fifteen years, E. E. CHEESMAN, F. J. POUND and their associates in the British West Indies have studied the problems of cacao cultivation in tropical America. Their work — which will remain one of the highlights in the history of tropical agriculture — has been aimed toward the vegetative propagation of strains resistant to disease, and at the same time productive of good-quality cacao in reasonable

* *Cf.* A. A. BITANCOURT, CHRON. 7, 7:319 (1943).

quantity. The problems have been complex, owing largely to the mixed genetic constitution of desirable varieties in general, as well as because the cacao tree is somewhat difficult to propagate vegetatively.

The prospects for Ecuador — at one time the world's greatest producer of cacao — are summarised by Professor CHEESMAN as follows: "At best it seems unlikely that the industry can ever regain all its former prosperity, but, fortunately, there are reasons for hoping that it can be partially rehabilitated through the application of modern methods of selection coupled with more intensive methods of agriculture."

*Bananas.* — From the standpoint of this discussion, the banana is of particular interest as illustrating the development of a tropical crop from the most primitive stage of agriculture to that of modern, intensive, scientific farming. It is all the more striking because this transformation has taken place within a period of less than twenty-five years.

Since the early years of this century, the banana industry has formed one of the chief sources of revenue for several of the Caribbean republics. Honduras has exported as many as thirty million bunches in a single year. Several British colonies — notably Jamaica — have played an important part in the industry, as have Mexico, and to a lesser degree, Ecuador.

Jamaica was perhaps the first region in which agricultural skill began to be applied to banana culture. Around the Caribbean, the methods used to 1920 or 1925 were crude. Little attention was devoted to the selection of soils; the only cultivation given was an occasional removal of weeds and "bush" with the machete, together with the cutting out of superfluous growth from the banana "mat" or stool.

The modernization of banana agriculture began at the logical point — the use of intensive soil surveys and the development of good drainage techniques; for in most of the regions where bananas are commercially grown, intensive drainage is a prime essential. Then came attention to the best types of planting material, followed by adjustment of plant populations to climatic and soil factors, so that every acre would carry the optimum number of plants. Production was greatly increased through widespread use of commercial fertilizers, chiefly those carrying nitrogen — the element most commonly lacking in tropical soils which have been farmed for a number of years.

Then in 1935, the industry was threatened by a leaf disease, *Cercospora musae* (commonly known as Sigatoka), which appears to have reached the American tropics in some unknown manner from the Far East. This was investigated by O. A. REINKING and V. C. DUNLAP, who found that it could be controlled by spraying with copper compounds (Bordeaux mixture is the material most commonly used) but at a price which necessitated its limitation to farms which were capable of producing large quantities of superior fruit. This involved the abandonment of many second-class soils, since the cost of spraying was practically as high as on the best lands and the yield not sufficiently great to justify the expense.

Concurrently with the installation of stationary spraying equipment and the laying of pipe through the farms for the convenient application of Bordeaux mixture came the development of overhead irrigation, the most efficient and economical means of applying water which has yet been used in the tropics.

*Coconuts and other crops yielding edible fats.* — The coconut has long been of importance as an export crop in the West Indies and in several other parts of tropical America. Its value as a cash crop has often tended to overshadow the fact that there has been a deficiency of edible fats for local consumption in many tropical countries, a deficiency which it is highly important to correct.

Coconut production has decreased in several regions, due to the ravages of insects and disease, and it seems doubtful that this trend will change. There is at present an active interest in the cultivation of other oil-yielding plants. The production of peanuts and the manufacture of peanut oil are assuming importance in Cuba; while sesame is attracting attention in Venezuela, Colombia, Nicaragua and elsewhere. There seems also to be a possibility that the African oil palm (*Elaeis guineensis*) may become a commercial crop in tropical America.

*Fibers.* — In recent years there has been marked increase of interest in cotton cultivation throughout this part of the world. Several programs, such as the one successfully carried out by CARLOS CHARDON in Venezuela, have had as their objective the supplying of cotton for local markets. The control of insect pests has been a problem in most instances. Economic factors enter into this whole situation and it remains to be seen whether countries such as Venezuela and Colombia will find it more satisfactory to grow cotton for their own needs, or whether they will import it from regions which can produce more cheaply, and on their part, grow export crops for which their own conditions of soil, climate, or labor seem better adapted.

The production of hard fibers such as the Agaves (henequen, sisal and their relatives) is on the increase in several countries, and has been given a great impetus by the scarcity of jute bags incident to the war.

*FRUITS AND FRUIT CULTURE:* — The problems of tropical pomology may perhaps be considered most profitably by separating them into two groups, (1) the propagation, culture, and improvement of such species as the avocado, the mango, and the various kinds of *Citrus;* and (2) the cultivation in tropical America of such non-tropical fruits as the apple, the peach, the grape, the olive, and the date.

The first step in the improvement of most fruits is the vegetative propagation of superior individuals which have occurred as chance seedlings. With regard to many of the so-called "minor" tropical fruits this step has not been taken; or, where it has been taken, people in general have not yet availed themselves of superior planting material. Thus, throughout tropical America, it is far more common to find seedling mangos and avocados than grafted varieties, despite the fact that the latter are available. They are not *readily* available in many places, however, and they are expensive, which effectively discourages widespread planting.

*Citrus fruits.* — Commercial cultivation, along modern lines, has been undertaken in many

regions. Oranges, grapefruit, and limes have been the principal species concerned, the varieties of the first two being, with occasional exceptions, those which have originated in California and Florida. There seem to be no problems which are not common to citrus culture generally. Sour orange is generally preferred as a rootstock; other species have been tried and will continue to be tried, in the hope that something may be found which is superior in resistance to gummosis and foot-rot. In this connection the practice of budding high — about two feet from the ground — which has been adopted at the Imperial College of Tropical Agriculture in Trinidad is of considerable interest.

Commercial planting of oranges and grapefruit for northern markets has not met with unqualified success in most regions, due more to economic than other factors. Perhaps the best hope for the future lies in increased quantity and variety of citrus fruits for local consumption. The orange is one of the most popular fruits in most tropical countries. The quality of the seedling fruits usually grown is sufficiently good: never-the-less, through the introduction of budded varieties, and the vegetative propagation of superior chance seedlings (which are of frequent occurrence), it will be possible to extend the season and to produce fruit with fewer seeds. It may be mentioned that the Bahia or Washington Navel orange does not develop high color or flavor when grown at low elevations in the tropics: it is more satisfactory when planted in the *tierra templada* at four or five thousand feet.

*Pineapples.* — The competition of canned pineapples from the Hawaiian Islands has greatly curtailed the demand in northern markets for fresh pineapples from tropical America. Nor has it been possible, so far, to develop a canning industry in this part of the world which could offer serious competition to Hawaii.

*Mangos.* — Because of its abundance and usefulness in many regions, the mango has been termed "the apple of the tropics." Though not native to tropical America, it is nearly ubiquitous in the *tierra caliente,* chiefly in the form of seedlings which produce fruits of excellent flavor but with so much fiber through the flesh that their attractiveness is greatly impaired. In recent years many choice varieties from India have been introduced and are beginning to be seen in tropical American orchards. These must be propagated by grafting, whereas mangos of the Philippine or Cambodiana group are fiberless even when grown from seed. These have been grown for many years in Mexico and Cuba, where they are highly esteemed.

Most of the grafted Asiatic varieties produce freely only when grown in climates which are relatively dry during a considerable part of the year. This is due (1) to the fact that these varieties require a check to vegetative growth, provided by dry weather, and (2) to a fungous disease (*Colletotrichum*) which destroys the flowers and is favored by moist weather.

Varieties differ in their ability to withstand unfavorable conditions. Widespread experimental planting is bringing to light the best; but there is another problem which must be solved before mango production can be wholly satisfactory. W. T. POPE in Hawaii, and H. P. TRAUB, C. O. CARRERO, and L. C. MCALESTER in Puerto Rico, have investigated this: the resistance of varieties to fruitfly attack. They have shown that it may be possible to grow varieties which are relatively resistant and at the same time satisfactory from the standpoint of quality and productiveness.

*Avocados.* — Few tropical fruits are of greater value, and more widely appreciated, than the avocado. Since pre-Columbian times avocados have been cultivated extensively in tropical America — though they did not reach the West Indies until carried there by the Spaniards. In recent years avocado growing has assumed commercial importance in California and Florida, where many valuable sorts have originated.

Most of the avocados seen in tropical America are seedlings, but grafted varieties — both those of local origin and many introduced from the United States — are beginning to be planted. The fact that there are three horticultural races, differing in their climatic adaptations, makes it possible to grow avocados in the *tierra caliente* as well as the *tierra templada;* while the development of crosses between the different races extends the period during which avocados can be available in any given locality.

In Cuba, in Puerto Rico, and elsewhere avocado culture is limited to certain areas. Whether this is altogether a matter of soil (avocados will not thrive on heavy lands which can not be given perfect drainage) or whether it is partly due to root diseases regarding which we know but little, remains to be determined.

*Temperate zone and subtropical fruits.* — Many a tropical horticulturist yearns to cultivate the highly improved and delicious fruits of the temperate zone, in addition to those better adapted by nature to his environment. This yearning goes back to the time of the Conquistadores, who brought with them from Europe the fruits and cereals with which they were familiar.

Little success attends such efforts in the *tierra caliente,* but at elevations of 5,000 to 10,000 feet it has been found possible to cultivate, with a limited degree of success, the apple, the pear, and the plum. Two — and perhaps more — factors militate against these fruits: first, the lack of winter chilling necessary to complete the rest period, and second, the lack of high temperatures to ripen the fruits properly. The last-named is not important in all cases, for apples of fair quality are often produced in the tropics, while plums are sometimes excellent.

Peaches are not so difficult, especially if one plants varieties containing blood of the South China races. Unfortunately the first peaches brought to tropical America were of European origin. These require more winter chilling than the South Chinese types. Never-the-less, seedlings are to be found in abundance throughout the tropical American uplands, and peaches are commonly seen in many markets. It would be worth while to select the best of these and propagate them by grafting; but the future of peach growing in the tropics undoubtedly lies mainly in the wider use of varieties containing a good proportion of South Chinese blood.

The possibilities of grape culture have never been adequately tested because plantings have been limited almost wholly to varieties of the *vinifera* species. These were first brought to

America by the Spaniards, who strove for centuries to produce wine such as that with which they were familiar in the homeland. They were fully successful only in subtropical regions — California and Mexico on the north, Peru, Chile and Argentina on the south. Throughout the equatorial zone, even at high elevations, European or vinifera grapes have never been grown with complete success on a commercial scale, though they are cultivated in many places.

The reason probably lies in the diseases to which this race is subject — diseases which cannot readily be controlled in the tropics. Strangely enough, some of the native American grapes, which come from climates even less tropical than the viniferas, will thrive in the tropical lowlands. The variety Isabella, believed to be a hybrid between *vinifera* and one of the American grapes, has for many years been grown commercially in central Brazil, and more recently in the Cauca valley of Colombia. J. L. FENNELL is now working on the production of hybrids combining the desirable qualities of the best European grapes with the disease-resistance of the American species. This is the proper line of attack and complete success seems within reach.

The olive is another fruit brought by the Spaniards and planted by them from California to Chile. In the equatorial regions it has never proved fully successful, though there are bearing trees in the highlands of Ecuador, and more notably, in the valley of Leiva, north of Bogotá, in Colombia, where specimens still exist which were planted in early times. These are growing at an altitude of 7,000 feet. Whether the lack of winter chilling is responsible for poor production, or whether other factors are involved, is difficult to say.

Because the date palm requires high temperatures to ripen its fruit it has often been assumed that it should be successful in the tropics. But the situation here is a very special one: not only does it require high temperatures, it requires much higher ones than those commonly experienced, together with humidity considerably lower than that of most regions in tropical America. Date palms are to be seen in gardens throughout this part of the world, but they do not ripen their fruit satisfactorily. In the hot dry valleys of southern Peru dates have been grown commercially on a small scale, and the region of Soatá in Colombia has a reputation for producing dates. But an investigation of this latter showed the elevation to be 6,000 feet; the climate not hot (as judged by the requirements of the date palm); and the fruit which is marketed in Bogotá never ripens properly, but is harvested when green and crystallized in syrup. The climatic requirements of the date have been thoroughly investigated by W. T. SWINGLE and others, and it is highly improbable that date cultivation will ever become of importance in the strictly tropical regions of America.

*PLANT INTRODUCTION AND NEW CROPS:* — History is full of incidents which stress the importance and the romance of plant introduction. On one (probably more than one) of his voyages, COLUMBUS brought seeds and plants from the Canaries to the newly-discovered Hispaniola. In one of his first letters to the King, HERNÁN CORTÉS asked that no vessel be permitted to set sail for New Spain without including in its cargo cereals and other seeds which would be useful to the colonists. BERNAL DIAZ DEL CASTILLO tells how he planted the first oranges near Coatzacoalcos, in the Isthmus of Tehuantepec. GARCILASO DE LA VEGA describes the joy of the Spaniards when the first grapes from Spain bore fruit at Cuzco. And so on.

Three centuries later, the recently-well-publicised voyage of Captain BLIGH was undertaken at the behest of the British government, to bring the breadfruit tree from Tahiti to the West Indies. In succeeding years, the Royal Botanic Gardens at Kew acted as a medium of exchange for plant materials between the tropics of the Old World and the New. In 1900, DAVID FAIRCHILD organised the Office of Foreign Seed and Plant Introduction in the U. S. Dept. of Agriculture. In our own times this institution, which FAIRCHILD directed personally for a quarter of a century and which is now headed by B. Y. MORRISON, has been one of the most active agencies connected with the exchange of economic plants between tropical American countries and other parts of the world.

It is not to be expected that the smaller republics can in many instances set up such elaborate machinery for the work of plant introduction as that which has been developed at Washington; never-the-less much has been done by experiment stations, by agricultural companies, and by individuals. Even so, the field is scarcely touched as yet and it is highly probable that some of the greatest achievements of tropical American agriculture during the next quarter of a century will be in connection with the introduction and establishment of new crops, or superior varieties of those already cultivated.

The technique developed by the U. S. Dept. of Agriculture includes the dispatch of agricultural explorers to interesting regions, as well as the conducting of an exchange by correspondence with government experiment stations, botanic gardens, horticulturists, travelers, and others. When plant materials arrive at Washington, they are carefully examined for the presence of dangerous insect and fungous pests, catalogued, and sent to one of the various plant introduction gardens for preliminary trial and propagation. Later, promising items are distributed to experiment stations, plant breeders, and amateurs interested in testing them under different conditions of soil and climate. Considerably more than a hundred thousand introductions have been made in the past forty years.

During the earlier years of this work, efforts were aimed primarily toward introducing crops new to the United States, such as the date palm and the tung oil tree, though attention was also devoted to securing new and desirable varieties of standard crops, such as the durum or macaroni wheats. Recently, as the possibilities of introducing crops altogether new to the country became more limited, the work has tended to center around securing material to be used by plant breeders; often wild plants which, when crossed with cultivated forms, might impart disease-resistance, hardiness, and the like. In fact, it may be permissible to divide the work of plant introduction into two well-defined stages on this basis.

Though selection of superior local strains and plant breeding have become accepted policies in several of the tropical republics, the work of

plant introduction is still largely in the first stage — that of introducing new crops, or superior varieties of those already cultivated. There are many opportunities in this field, though it must be admitted that it is not easy to introduce completely new crops which will fulfill the aspirations of agriculturists who desire something which can be cultivated extensively and profitably for export.

At the moment, the situation is somewhat different, due to the war. A number of agricultural products, for which the New World was formerly largely dependent on the Asiatic tropics, are now being planted commercially: three of these will be considered below in some detail.

In the long run, the greatest value of plant introduction in tropical America may lie in filling the lacunae which exist today in the national economies of the various republics. History will decide. But there are many and urgent needs along this line. For example, the introduction of a superior forage plant for the *páramos* or high, cold plains of the Andes would have immense importance, as would the introduction of satisfactory forage crops for many other specialised conditions. The introduction and establishment of a wider variety of vegetables for improving local dietaries is also much to be desired.* And there are attractive possibilities in the field of fruit culture. Some of these have been pointed out above.

The Chinese lychee and the kaki or Japanese persimmon are two fruits which can be grown widely in tropical America, but which at present are seen in only a very few countries. Both would meet with popular favor. The mangosteen, one of the finest fruits of Malaya, is so rare in the American tropics that the places where it is grown can practically be counted upon the fingers of one's hands.

The Asiatic bamboos constitute another group of plants which have received little attention in tropical America, and which eventually should assume an important place in the economy of these regions, as they have done long since in the Orient. Timber trees for specialised uses; drug plants and plants yielding insecticides such as rotenone; oil-yielding plants — all these and many others might be added.

To pursue this work effectively, organization and equipment are required. The human element is the most important — good plantsmen to receive the seeds and plants which arrive, and nurse them through the early stages of their growth. Progress along these lines has been made in several regions. It is only necessary to mention the splendid work of the botanic gardens maintained by the British government in the West Indies; the Harvard Botanic Garden at Soledad, near Cienfuegos, Cuba; the agricultural experiment stations in Puerto Rico; the Estación Experimental Agronómica at Santiago de las Vegas, Cuba; and the recent activities of the Venezuelan, Colombian, and Ecuadorian governments, to prove that this subject is receiving serious attention.

As excellent examples of what should be done and how it is to be achieved, we may cite the history of three strategic crops now subjects of major effort on the part of tropical American agriculturists. These are *Hevea* or Pará rubber; Abacá or Manila hemp; and *Cinchona*, the tree which produces the important drug quinine.

*Hevea.* — Years before the outbreak of the present war, the seriousness of our dependence upon the Far East for our supplies of rubber was recognized, and steps were taken to correct the situation. In the 1920s, O. F. COOK of the U. S. Dept. of Agriculture organised a program of investigation and experimentation, while surveys of the possibilities in many parts of tropical America were carried out under the aegis of the U. S. Dept. of Commerce. Small experimental plantings were made by the United Fruit Co. in Costa Rica and Honduras. Other small plantings had been made earlier in Mexico, in Haiti, in Nicaragua, in Ecuador, and elsewhere.

Somewhat later, the Goodyear company, bringing grafted material of superior clones from its plantations in the Orient, commenced experimentation in Costa Rica under the direction of WALTER BANGHAM and W. E. KLIPPERT.* This work has been, and is, an outstanding example of plant introduction intelligently conducted along modern lines. The Ford Company in Brazil has also done notable work; while the U. S. D. A., in collaboration with various tropical governments, is now conducting what is probably the most extensive program of plant introduction ever undertaken in the Americas. E. W. BRANDES†, R. D. RANDS, LOREN POLHAMUS and their associates have devoted much attention to exploring the possibilities of wild rubber trees on the Amazon; to the development of superior techniques in propagation; to the control of disease; and to other problems connected with the successful production of *Hevea* rubber in tropical America on an extensive commercial scale.

*Abacá or Manila hemp.* — In the 1920s the U. S. D. A. recognized the necessity of having a supply of this important fiber available in the western hemisphere and sent H. T. EDWARDS to the Philippines to secure planting material. "Heads" (pseudobulbs) of the five leading commercial varieties were brought to Panama. Previously abacá had been represented in this hemisphere only by inferior stock grown from seed, unsuitable for the production of commercial fiber.

The EDWARDS introductions were propagated principally at Almirante, by the United Fruit Co. The low prices realised by abacá fiber in New York during the early 1930s, together with the great differential in the cost of decortication between the Philippines, with its relatively cheap labor, and Panama, discouraged commercial exploitation for the moment; but small plantings were maintained with the object of expansion when the time arrived. With the advent of the war in 1941, abacá immediately assumed great importance as a strategic crop and thousands of acres have been planted, and thousands

* DR. PENDLETON comments: "Occidentals, because they are used to annual vegetables, grown close to the ground and needing daily watering and care, have expended much effort to get Orientals to produce and eat the same sorts. The Siamese and Malays are more practical, in that they use many kinds of flowers and young leaves and shoots from shrubs and trees which need no protection from pigs, chickens, and cattle, and which grow through the dry season without watering. In Siam, *Sesbania* flowers are very popular for salads: the young shoots and young pods of *Leucaena glauca* are commonly used as vegetables."

* *Cf.* CHRON. 6:199 (1941).

† *Cf.* CHRON. 7, 7:320 (1943) and this volume, p. 183 and p. 199.

more are now being planted, in Panama, in Costa Rica, in Honduras, and in Guatemala.

*Cinchona.*—Originally obtained from wild trees in the Andes, quinine became an important product of the eastern tropics toward the end of the last century, and at the outbreak of the present war Java was supplying 95% of the world's needs. Along with rubber and abacá, quinine was placed on the list of strategic crops after World War I, and in the early 1930s organised efforts to expand quinine production in tropical America were set on foot.

The problems connected with *Cinchona* production are mainly agricultural, whereas in the case of abacá they have been chiefly of an economic nature. Abacá, a close relative of the banana, is slightly more exacting than the latter with regard to soil and climate, but in general it can be said that abacá will grow on most first-class banana lands, and its culture presents few difficulties. *Cinchona,* on the other hand, is highly exacting with regard to soil and climate; and in addition, *Cinchona* as a genus is extremely variable, there being many forms in cultivation as well as natural hybrids.

Guatemala was chosen as the base for experimental work. Here were assembled by Experimental Plantations, Inc. (a subsidiary of Merck and Co.) in coöperation with the U. S. D. A. and the Guatemalan government, varieties from many parts of the world. Their propagation and their cultural requirements were studied; small plantings were made on different soils at different elevations; and advantage was taken of the experience gained in earlier years, when efforts had been made to establish this crop in Guatemala.

It requires six years or more for a *Cinchona* tree to attain suitable size for exploitation of its quinine. The work has therefore been slow. But much has been learned, and the ultimate prospects seem good. The situation is a complex one, and a number of questions must be answered. Will synthetic quinine or products such as atabrin eventually replace natural quinine? To what extent? Should the objective be the production of quinine, or will totaquina (a product consisting only of quinine, but of other alkaloids contained in *Cinchona* bark) assume commercial importance and perhaps replace quinine? If quinine is the objective then it will be necessary to grow varieties of *Cinchona* which yield relatively high percentages of this drug; while on the other hand, if totaquina is to be used, stronger-growing forms with less exacting requirements of soil and climate can be employed.

*AGRICULTURAL EDUCATION:*—Throughout the American tropics much attention is being devoted to agricultural education. It therefore seems worth while to review the subject and its problems; though it must be admitted at the outset that opinions differ on many points. For convenience, the field may be divided into (1) vocational training, and (2) the preparation of teachers, investigators, and extension workers.

Vocational schools, frequently called "granjas," are to be found in many republics. Cuba has one in each province; Guatemala has one, called the Escuela Nacional de Agricultura, giving a five-year course; Venezuela has one at Maracay; Colombia has several; Ecuador has its long-established Quinta Normal de Agricultura at Ambato. The United Fruit Co. has recently donated $500,000 to establish one in Honduras, known as the Escuela Agrícola Panamericana. And there are others.

These institutions may perhaps be compared to agricultural high schools of the United States. Training is practical as well as theoretical. Many of them give their graduates the title of "Perito Agrícola" or "Perito Agrónomo."

Farmers sometimes criticise these schools on the ground that they attempt to teach too much, and that there is insufficient stress upon the relationship between theory and practice. If such criticism is justified, it may be due in part to the curriculum, but is probably more largely due to the dearth of well-trained teachers and an almost complete lack of texts adapted to local conditions.

This lack of adequate texts in the language of the country has come in for much attention recently and seems in a fair way to be remedied. Brief, elementary, modern texts in Spanish are greatly needed. These should stress the relationship between theory and practice, and must cover most of the natural and physical sciences. They must be based on tropical conditions but many of them could probably be sufficiently general in character to meet the needs of Nicaragua as well as Venezuela.

Other texts are required to meet definitely local situations with respect to such matters as soils, crop production, insect pests and plant diseases. It may be a long time before a sufficient number of these are available; but in the meantime the problem would be solved in large part through the provision of the series first mentioned.

Technical training, leading usually to the degree of "Ingeniero Agrónomo" (the term "ingeniero," engineer, does not have the same connotation in Spanish as in English) is provided by many agricultural colleges, some of which are units of national universities in the tropical republics. Mexico has a modern and well-equipped one at Chapingo, where men are trained entirely at the expense of the national government. Costa Rica has one, now part of the recently-incorporated Universidad de Costa Rica. Colombia has one at Medellín and another at Cali, the former supported by the national government, the latter by the Departamento del Valle. Venezuela has one near Caracas. Cuba has a well-equipped unit of the University of Habana. Puerto Rico has its long-established College of Agriculture at Mayagüez. And so on.

In a class by itself is the Imperial College of Tropical Agriculture at Trinidad, supported by the British government, which aims primarily at post-graduate training and research, but also provides a three-year undergraduate course leading to a Diploma.

As in the case of the vocational schools, many of these colleges of agriculture are seriously handicapped by lack of satisfactory texts and the difficulty encountered in securing the services of teachers who have both theoretical and practical training in the subjects they handle.

In fact, the provision of good teachers has been one of the most difficult problems which has had to be faced by these schools. Many attempts have been made to solve it by bringing well-trained teachers from abroad. With occasional notable exceptions, this method of ap-

proach has not worked out satisfactorily. Glancing over the field, it is difficult to name a handful of foreign teachers now at their posts who have been there continuously for several years. The tendency has been for men to come and go (not always the fault of the teachers), with consequent dissatisfaction on the part of those responsible for the management of the schools, and disruption of the work.

The ideal solution would seem to be the sound preparation of native teachers. This means, in many instances, that they may have to go abroad for study; and it most certainly means that they should have full-time employment on the teaching staff. In one tropical institution with about 125 students there are some thirty-five teachers, only a few of whom devote all their time to teaching. The remainder are business and professional men who come to the school periodically to deliver lectures and supervise classroom work. This system might be satisfactory where advanced specialised training is the objective; but it does not seem altogether satisfactory where undergraduate students are concerned. It has been forced upon the schools by financial handicaps and the lack of well-trained technical men willing to make a career of teaching.

If the difficulties encountered in the training of teachers are great, they are still more so with respect to the preparation of men for research and investigational work. And this is a field in which the needs are urgent and have long been recognized. Here again, a solution has oftentimes been sought through the employment of foreign specialists to work on definite problems or to supervise agricultural research in general. As with the employment of foreign teachers, this system has occasionally proved satisfactory; more often it has not. And it has the overwhelming objection that it does not assist, to the desirable extent, in the development of a body of technical men, native to the countries in which they work and devoted to its ideals and its future.

There are involved no undesirable features of nationalism. Quite the contrary. One can only be sympathetic with the statement of a group of graduates in Colombia, who posed the problem as follows:

"Our agricultural needs can only be met through the application of more scientific knowledge than we possess today. For example, we need to know more about our soils; we need to know more about rice culture; we need to improve our technique in the selection and propagation of cacao varieties. How are we going to bring good ability, training, and experience to bear on such matters?

"If we bring men from abroad to help us, we have to pay them large salaries. During the first year or two, they must devote most of their time to becoming familiar with conditions in our country. Often they are handicapped by not knowing Spanish, which means that they are not wholly effective in passing on to our agriculturists the information they have brought with them or acquire here. And then — and this is the most serious feature of all — they usually go home just about the time they commence to be useful to us.

"Recognizing that there have been exceptions; recognizing that in some instances we should still employ foreign specialists, we feel that our case is a strong one. Instead of bringing men from abroad, why not use the same money to send us to Trinidad, to Mexico, to Chile, to the United States, or wherever are to be found the best men in any given field of specialization? We believe we have the ability to become proficient, given the opportunity to study under real experts. And when we come back home, we are here to stay. We belong to the country, we speak the language, and we understand the psychology of the people."

Such a policy is now meeting with widespread recognition. National governments in the tropics are providing more and more scholarships for advanced students, while the U. S. government and many institutions in the United States are doing the same. In the long run, it is believed these scholarships will do more toward the solution of the general problem of providing efficient teachers, research men, and extension workers, than anything else which can be done.

At the same time, there is much hope in the program now being placed on foot by the Office of Foreign Agricultural Relations of the U. S. D. A. This involves the establishment of coöperative experiment stations in a number of tropical countries, staffed in part by North Americans whose salaries are paid by U. S. government — thus avoiding the criticism that monies are being spent on foreign experts which should go into advanced training of tropical nationals. And it is planned in each case to train Latin-Americans to take over the jobs as rapidly as they become prepared to do so.

A somewhat similar program is being carried out by the Office of the Coordinator for Inter-American Affairs at Washington, which has sent numerous commissions to tropical American countries, where they are providing technical assistance along practical lines. Assuming that many of these men will not remain permanently in the tropics, their value is great from two angles: they will train tropical nationals for technical work, and some of them, when they return to the United States, will be teaching in schools where students from the tropics will get the genefit of their Latin-American experience.

*EXPERIMENT STATIONS**: — The beginnings of experiment station work in tropical America go back to the establishment of botanic gardens in the British Colonies. Though these institutions served primarily as centers for the introduction and testing of economic plants, several of them eventually became, and have remained, experiment stations in the modern sense of the term.

In the tropical republics, experiment station work is of more recent inception, and its history has commonly been marred by one serious defect: lack of continuity. If one factor is more to blame for this than others, that factor is probably politics; but fairness demands that much of the responsibility be placed upon inability to shoulder the financial burdens involved.

Nothing is to be gained by reviewing the failures — the stations which have been established, only to languish for lack of funds and capable personnel, or to fall by the wayside before they had been in operation sufficiently long to achieve worthwhile results. On the credit

* *Cf.* CHRON. 7, 2:49 (1942) and this volume, p. 337.

side of the ledger there are some notable items, and the prospects now seem brighter than ever before.

Forty years ago, F. S. EARLE, C. F. BAKER, W. T. HORNE and their associates established the Estación Experimental Agronómica at Santiago de las Vegas, just outside the city of Habana, Cuba. The enthusiasm and energy of this group accomplished much. Such names as GONZALO FORTÚN, JUAN T. ROIG, S. C. BRUNER, FERNANDO AGETE and JULIAN ACUÑA are connected with the history of this station in more recent years; and it is to be remarked that it is one of the institutions which has never ceased to function, though not always upon the scale originally planned.

Mexico has its stations; Guatemala has none as yet, though several small units, more in the nature of plant introduction gardens than anything else, were established by the Servicio Técnico de Cooperación Agrícola in the late 1920s and are still carried on by private enterprise. Salvador has a station operated by the Asociación Cafetalera and is shortly to have a more ambitious one, established by the government in coöperation with the Office of Foreign Agricultural Relations of the U. S. D. A. Honduras has Lancetilla Experiment Station at Tela, established in 1925 by the Tela Railroad Co. (subsidiary of the United Fruit Co.), where extensive work of plant introduction has been carried out, as well as much research on cultural problems. At present this station is also serving as one of the tropical bases for rubber investigations of the U. S. D. A. — more particularly for work in the propagation and dissemination of superior types of *Hevea* rubber.

Nicaragua has a small station at Masatepe, and is now organising a coöperative station on the Atlantic side, similar to the one in Salvador. Costa Rica has a small station in conjunction with the agricultural college at San José, in addition to the extensive experimental work on rubber which the Goodyear company is carrying out near Cairo, and the rubber investigations of the U. S. D. A. based at Turrialba.

The Republic of Panama has recently established a modern experiment station near Divisa. The Canal Zone has its Experiment Gardens at Summit, where valuable work in plant introduction has been done by HOLGER JOHANSEN, J. E. HIGGINS, and more recently by WALTER LINDSAY and his associates.

The Colombian government has in recent years established a number of small stations, strategically placed to investigate the problems connected with particular crops: thus there is one for wheat and another for potatoes on the sabana of Bogotá; one for temperate zone fruits at Duitama; one for cacao in the Cauca valley; and so on. More general in its interests, and with a longer history, is the modern experiment station at Palmira, in the Cauca valley, directed by RAUL VARELA MARTINEZ. Ecuador has a small station in conjunction with the Quinta Normal de Agricultura at Ambato, in addition to several other small ones recently established in the highlands; and the projected station near Guayaquil, in coöperation with the Office of Foreign Agricultural Relations at Washington. A similar station has been established at Tingo Maria, on the Amazonian side of the Peruvian Andes, under direction of B. J. BIRDSALL.

Venezuela has a modern station at Sosa, near Caracas, in addition to several smaller ones. Puerto Rico has been the scene of continuous and well-organised experimentation since the early years of this century. In recent times, notable work has been done at the Federal experiment station in Mayagüez, under the direction of ATHERTON LEE; at the Insular station in Rio Piedras, under J. A. B. NOLLA; and at the Tropical Forest Experiment Sation, under ARTHUR BEVAN.

This by no means exhausts the list: nothing has been said of work done in northern Brazil, in Haiti, and in Santo Domingo. Nor has mention been made of the various activities of the British and French in their respective colonies, nor the notable achievements of G. STAHEL and his associates in the Dutch colony of Surinam. The extensive and important investigational work carried on during the past fifteen years at the Imperial College of Tropical Agriculture in Trinidad is unique in the history of tropical American agriculture.

Despite this impressive list of institutions, it must be admitted that many others have been started — as has already been mentioned — only to terminate their activities before any good had been accomplished: and it must be pointed out that many of the stations in existence today are inadequately staffed. The opportunity is there, the machinery is actually available; but the men to run it do not have, in some instances, sufficient training to get efficient work out of it. As has been mentioned above, the Office of Foreign Agricultural Relations of the U. S. D. A. is making a well-organised and extensive endeavor to assist in remedying this situation, through supplying personnel for stations operated in collaboration with the governments of several countries.

This is the place to mention the Instituto Interamericano de Ciencias Agrícolas which is being established at Turrialba, Costa Rica (*cf.* CHRON. 7, 7:333, 1943). Its objectives are partly educational, partly research. It is a coöperative project fathered by HENRY A. WALLACE, Vice-President of the United States, and directed by EARL N. BRESSMAN. While not solely tropical in its interests, it will devote much attention to the investigation of problems connected with tropical agriculture. Because of its all-American scope, and the support of various American governments, this promises to become one of the most useful and important institutions of its sort which has been established in the western hemisphere.

*EXTENSION:* — One may perhaps be permitted to visualise the agricultural development of the American tropics in some such terms as the following: First, plant introduction; second, investigation and experimentation; and third, extension. Some of the tropical republics are in the first stage or entering the second — for these two go hand-in-hand to a large degree. Others are beginning to enter the third. Puerto Rico has been in this stage for some time. Extension work is a recognized policy and has been carried out on a large scale. Cuba and Colombia are commencing to undertake extension activities: the former has an extension worker in every municipality, the latter has a group of "agrónomos regionales" whose functions are somewhat comparable to those of county agents

in the United States. Haiti has done much work along these lines; and extension is being attempted elsewhere.

The difficulty lies, frequently, in the scarcity of well-trained personnel, and in keeping the work out of politics — or to put it more accurately, keeping politics out of the work. It takes time to train good extension workers. The danger lies today in sending out too many young graduates of local agricultural schools, men who have had theoretical training but insufficient practical experience to meet the farmer on his own ground. In all countries, farmers are innately conservative, and at the start suspicious of anyone who does not talk on the basis of long practical experience. The difficulties of the extension worker are greater if the farmer thinks political aspects are involved.

Notwithstanding these features, the future of extension work seems bright, for it is characteristic of the small farmer in Latin America that he is less suspicious of science when backed by practical experience than is his North American colleague. If the extension worker really knows his business, it takes but a small time for him to gain the confidence of the men he attempts to influence.

*IN CONCLUSION:* — It is obviously impossible to cover thoroughly the entire field of tropical American agriculture in a discussion of this length. Hence the title of this paper — "*Some* Problems of Tropical American Agriculture." And it must be remembered that there may be other opinions of equal or greater merit, especially when based upon extensive field experience.

Finally, it may be pointed out that the major problems of tropical American agriculture are perhaps those of the Amazon and the Orinoco, of the Carribean littoral of Central America, and of the lowlands of southern Mexico — that is to say, the great undeveloped rain-forest areas which have so far proved difficult of development and in the last analysis may be best suited for the specialised cultivation of export crops. In the relatively dry uplands subsistence agriculture is simple, and man finds the climate more to his liking. These regions have long been populated with agriculturists — many of them since prehistoric times.

It will take the enthusiasm of men like Felisberto Camargo, plus much hard and often discouraging work, to realise the possibilities of regions such as the Amazon basin; and here as elsewhere it should always be remembered that the simple things come first. We must build from the bottom upward: *we must learn to walk before we can run.*

Escuela Agrícola Panamericana,
Tegucigalpa,
Honduras.

A. C. Smith and I. M. Johnston: **A Phytogeographic Sketch of Latin America:** — The papers discussing in more or less detail the phytogeography of the various political units comprising Latin America, making up a part of the present volume, represent the opinions of numerous specialists who have, in turn, based their conclusions upon the innumerable published works bearing on the problem, as well as upon the results of their personal investigations. The purpose of this introductory chapter and the accompanying generalized map is to present a summary of the entire subject in brief form. The authors have freely called upon the detailed papers for data and have attempted to summarize the problem, reconciling the terminology to a certain extent, and combining the various detailed maps as far as this could be done within the limitations of such a large-scale map as the one here offered.

The accompanying map is intended only as the most preliminary statement of vegetational zones in Latin America. The authors are fully aware of its shortcomings, some of which are due to the difficulties of suggesting, in publishable form on a small map, the enormously intricate regional zonation of the area under consideration, and others of which are due to lack of personal experience and lack of adequate published treatments of certain extensive areas. Even in those areas which have been described in detail by various writers, there is often such a lack of agreement among students that the present writers could attempt only to strike a balance among the conflicting treatments.

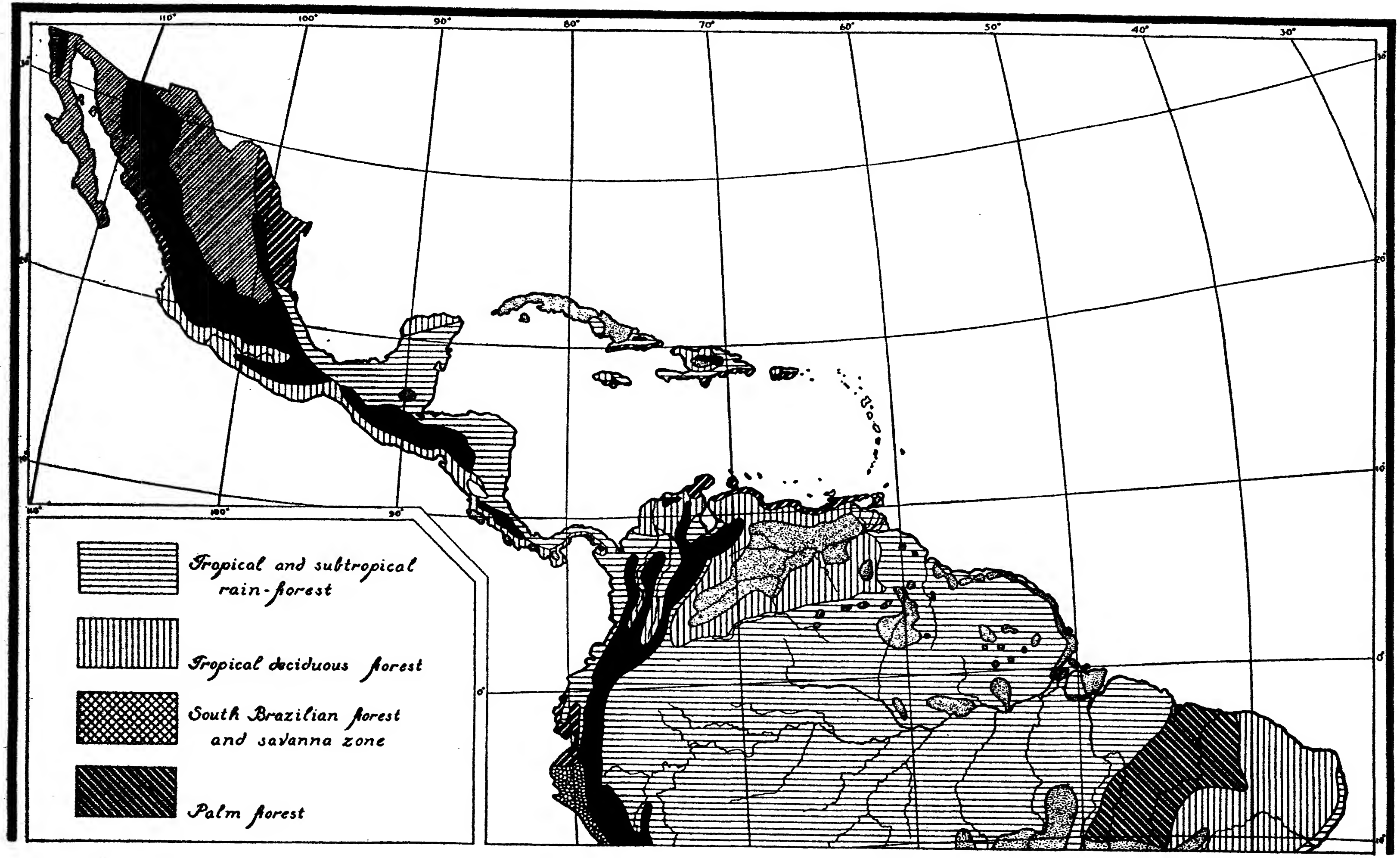
It should be emphatically pointed out that a map of this sort, by its nature, utilizes definite inter-zonal boundary lines, but that such definite lines seldom or never exist in nature is obvious to all botanists and travelers. In drawing such lines, we by no means guarantee their accuracy; for the most part they are highly arbitrary and should be so construed. Many of the lines on our map could be moved one way or the other a hundred miles or more and still remain as reliable as we have drawn them. Each inter-zonal line represents not a sharp break, but a transition; many of the zones themselves are so completely transitional as to be practically undefinable.

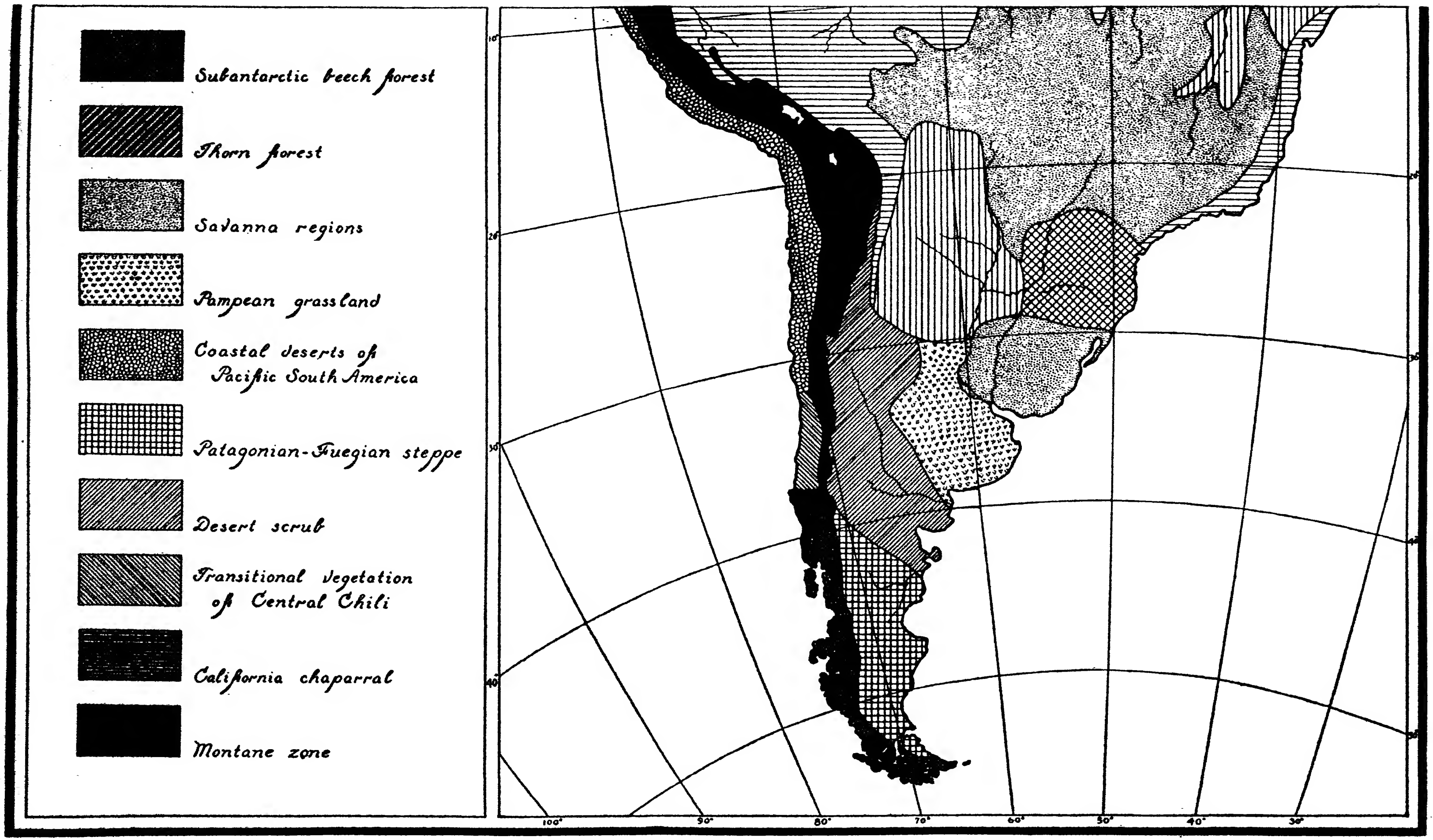
Another difficulty which besets the path of botanists rash enough to draw phytogeographic maps is terminology. Some of the available detailed maps utilize local terminology for their concepts, while others are so detailed that the broad lines are difficult to comprehend and still harder to transfer to a large-scale map. Our terminology, therefore, like our inter-zonal lines, is largely a matter of compromise.

In attempting to correlate phytogeographic zones under larger concepts, we find it convenient to classify them under three headings: (I) forests or wooded areas, (II) grasslands and savannas, and (III) deserts or semi-desert regions. In addition, we propose a fourth major heading, designated as a (IV) montane zone, in which all the highlands of the Andes and the Central American mountains are combined. Because of the great diversity of these highlands and the comparatively narrow limits of their component zones, we are unable to show them in more detail on our map. A fifth major heading, not shown at all on the map, is the narrow (V) maritime or littoral zone. Following is the general scheme of classification utilized:

I. **Forests or Wooded Regions.**
   1. **Tropical and subtropical rain-forest.**
   2. **Tropical deciduous forest.**
   3. **South Brazilian forest and savanna zone.**
   4. **Palm forest.**
   5. **Subantarctic beech forest.**
   6. **Thorn forest.**

II. **Grasslands and Savannas.**
   1. **Savanna regions.**
      a. **True savannas.**
      b. **Uruguayan savannas.**
      c. **Campo.**
   2. **Pampean grassland.**


110°
100°
90°
80°
70°
60°
50°
40°
30°
Tropical and subtropical rain-forest
Tropical deciduous forest
South Brazilian forest and savanna zone
Palm forest




A GENERALIZED PHYTOGEOGRAPHIC MAP OF LATIN AMERICA
(Map drawn by G. W. DILLON, under the supervision of A. C. SMITH)

III DESERTS OR SEMI-DESERT REGIONS.
1. Coastal deserts of Pacific South America.
2. Patagonian-Fuegian steppe.
3. Desert scrub.
4. Transitional vegetation of central Chile.
5. California chaparral.

IV. MONTANE ZONE.
1. Mexico, Central America, and the larger West Indies.
2. Northern Andes.
3. Southern Andes.

V. MARITIME OR LITTORAL ZONE.

## I. FORESTS OR WOODED REGIONS

1. *Tropical and subtropical rain-forest.* — The Amazonian rain-forest is the most extensive continuous rain-forest in the world, occupying an immense area in the Amazon drainage-basin; in its greatest east-west extent this forest approaches 2200 miles, and in a north-south direction across the Rio Negro-Rio Madeira basins it exceeds 1200 miles. The vegetation of this area is influenced by a high even temperature, heavy rainfall, and alluvial soil. The dense forest is divisible into three general types—the upland forest above flood-level, the "varzea" or flood-plain forest, and the "igapó" or nearly continuously inundated forest. In addition, there are innumerable local associations, and toward its southern borders the rain-forest merges with the "campo" of Matto Grosso in an ill-defined junction. In addition to Amazonian Brazil, a tropical rain-forest covers most of the Guianas, southern and eastern Venezuela, and the portions of Colombia, Ecuador, Peru, and Bolivia drained by tributaries of the main river. North of the Amazon the forest is broken by extensive patches of savanna, some of which (*e.g.* those of the Rio Branco-Rupununi region) are immense cattle-raising districts. A strip of mountainous territory along the Venezuelan boundary supports a flora of such spectacular endemism that it should perhaps be separated as a distinct vegetational zone, but on such a large-scale map as ours this detail is lost in the vast forested area (PL. 5, 6, 9*a*, 12*a*).

Along its western borders, the rain-forest ascends the Andes and merges with the temperate forest. The intermediate zone, perhaps best considered a *subtropical rain-forest,* is not separated from the lowland forest on our map. In Colombia, Ecuador, Peru, and Bolivia, this subtropical forest occupies roughly the wet Andean slopes between 1000 and 2500 meters. A tongue of its extends south from the "Yungas" region of Bolivia into northern Argentina; this is the so-called "Tucumán-Bolivian forest" (HAUMAN in Bull. Soc. Bot. Belg. 64: 51. 1931).

A forest very similar to that of the Amazon, and acted upon by an essentially similar climate, is the coastal rain-forest of Brazil. Like the Amazonian forest, this coastal forest shows a great diversity of species and supports a mass of lianas and epiphytic vegetation.

To the north, a forest essentially similar to the great Amazonian rain-forest is found in Venezuela south of Lake Maracaibo, in Colombia along the Magdalena and its tributaries, on the western slopes of the Andes in Colombia and northern Ecuador (a region of extremely high rainfall), in the eastern portions of the Central American countries north into Mexico, and to a more limited extent on the larger West Indian islands (PL. 7).

It is not to be assumed that the rain-forests thus outlined, and shown on our map to a greater or lesser extent from Mexico to Argentina and southern Brazil, are uniform in constitution. On the contrary, they disclose a high degree of local differentiation, being grouped together only because of a superficial resemblance and because they are acted upon by more or less similar climatic forces.

2. *Tropical deciduous forest.* — Forests of which the components generally lose their foliage during an extended dry season are found widely dispersed through northern South America. This formation attains its climax in areas where there are two well-defined seasons, and the appearance of the vegetation undergoes striking changes during the year. An extensive development of such a *tropical deciduous forest* occurs in the Orinoco basin and adjacent Colombia, flanking the "llanos" to both north and south, occurring in extensive patches in the savanna itself, and merging with tropical rain-forest to the south and coastal xerophilous vegetation to the north. The trees of this deciduous forest are of moderate height and often have straight columnar trunks; doubtless similar types of vegetation occur to the east in Guiana, so mixed with savanna and rain-forest as to be insignificant on a large-scale map. The terms "monsoon forest" and "sub-xerophilous forest" have been proposed for this general type of vegetation in Venezuela and Colombia.

In northern Colombia, in the lower Magdalena region, there are extensive sub-xerophilous forests or thickets, often dominated by *Mimosaceae,* which we also classify as *tropical deciduous forest.* Extensive areas of a somewhat similar vegetation, but in local pockets even more inclined to resemble a semi-desert type, occur in the upper Magdalena and Cauca valleys.

Along the Pacific coast of Central America from Panama north to Mexico and in portions of Yucatan a similar *tropical deciduous forest* occurs, in a region which similarly has a marked dry season. In certain regions this forest is lower than that of Venezuela and Colombia and perhaps gives way to xerophytic thickets. Toward the north it may take on the aspect of a semi-desert or thorn-scrub and may scarcely merit classification as a forest. The larger West Indian islands also support considerable areas of *tropical deciduous forest,* which is often scarcely to be distinguished from thorn-forest.

Under the general heading of *tropical deciduous forest* may be placed two large regions of eastern and central South America, the "caatinga" of northeastern Brazil and the "chaco" of Bolivia, Paraguay, and Argentina.

*Caatinga.* The arid northeastern portion of Brazil, locally known as the "caatinga," is basically an open scrub forest composed largely of deciduous trees. This is an area with a marked dry season and fairly impervious soil, which retains no moisture for the long period of drought. Here and there in the "caatinga," especially toward its eastern and southern borders, are true forests and intrusions of "campos." Much of the heavier forest of the "caatinga" has been cut, but the fundamental character of the region appears not to be due to interference by man. There are many species of cactus in the "caatinga," which in some parts bears a superficial resemblance to the dry portions of the "chaco" (PL. 8).

*Chaco.* The vast "chaco" of northern Argentina, southeastern Bolivia, and western Paraguay

has been discussed at length by many writers but is still only vaguely delimited. The boundaries of the "chaco" have been variously interpreted, and as placed on our map they are somewhat arbitrary. Primarily, the region is an immense plain scarcely exceeding 200 m. in elevation. The vegetation is essentially a mixture of xerophilous forest and savanna, with many halophytic and swampy associations; toward its eastern border hygrophilous forests follow the often-flooded river-banks. Most of the trees of the "chaco" lose their leaves in winter. The undergrowth often consists of spiny acacias and other members of the *Leguminosae, Zygophyllaceae, Cactaceae,* etc. The savannas of the "chaco" are marked by an abundance of tall palms and by isolated trees of *Acacia, Prosopis, Schinus,* etc. (PL. 9*b*, 10).

3. *South Brazilian forest and savanna zone.* — One of the most difficult South American zones to interpret is that which occupies a major portion of the States of Paraná and Santa Catharina, the northern part of Rio Grande do Sul, the Argentinian Territory of Misiones, and adjacent eastern Paraguay. In considering this a transitional zone and in terming it the *South Brazilian forest and savanna zone* we follow the suggestion of HAUMAN (Esquisse phytogéographique de l'Argentine subtropicale . . . In Bull. Soc. Bot. Belg. 64: 20-64. 1931). The well-known hygrophilous forests of Misiones and the adjacent regions are essentially tropical rain-forests, differing from those of the Amazon and the Brazilian coast only in degree. Toward the south, this forest merges with the extensive savannas which occupy the southern part of Rio Grande do Sul, Uruguay, and adjacent Argentina. In the Brazilian States which we refer to the *South Brazilian forest and savanna zone* there are extensive patches of more or less open land suggestive of the "campos" of central Brazil. Also in this region of Brazil are large stands of forest dominated by the Paraná pine (*Araucaria angustifolia*), which is so characteristic that many students refer to the whole region as the "Paraná pine zone;" in general these forests are very dense, but sometimes they are park-like and with scattered savannas. The Paraná pine zone is probably best considered as a rather specialized local aspect of a larger transitional *South Brazilian forest and savanna zone* (PL. 11, 12*b*).

4. *Palm forest.* — The north-central part of the Brazilian plateau, chiefly that part occupying the States of Maranhão and Piauhy, is occupied by a very specialized vegetation which is best separated as a zone of *palm forests.* This region, the "cocaes" of the Brazilians, supports extensive forests of palms of the genera *Copernicia, Mauritia,* and *Euterpe,* in addition to nearly pure stands of *Orbignya Martiana.* This zone has six fairly rainy months and its soil is porous. Toward the west a border of brushy lowlands forms a transition to the Amazonian rain-forest, while to the south there are extensive intrusions of "campos" and to the east large stands of the arid forests of the "caatinga" (PL. 13).

5. *Subantarctic beech forest.* — Luxuriant temperate rain-forests (comparable to those of the coast of Oregon, Washington, and British Columbia), with high precipitation during all months of the year, and characterized by *Nothofagus,* occupy most parts of southern Chile at low and middle elevations. The eastern border of this zone, adjacent to the Patagonian steppe, is drier and is characterized by deciduous arborescent species.

6. *Thorn forest.* — Open growth or dense thickets of small trees or arborescent shrubs, usually containing *Prosopis, Acacia, Mimosa,* and other thorny deciduous shrubs, develops at the dry edge of the tropical forest, commonly as a transition to desert scrub. The formation is xerophytic, developing at low altitudes in warm regions where there are alternating dry and moderately wet seasons. It is well developed in eastern Tamaulipas, north of the wet tropical forests of Vera Cruz. On the Pacific coast of Mexico the formation is well developed in western Sinaloa, and patches of it may be found on the coastal plain as far south as Oaxaca, Chiapas, and in Central America to Costa Rica. It is also present, between the wet tropical forest and the Pacific coastal desert, in southwestern Ecuador and adjacent Peru. Probably also to be referred here are the xerophytic thickets of northeastern Colombia and coastal Venezuela, various coastal areas of West Indian islands, and portions of Yucatan.

## II. GRASSLANDS AND SAVANNAS

1. *Savanna regions.* — The term *savanna* has been very loosely used in phytogeographic discussions. Apparently it was first used by OVIEDO in 1535, in reference to the Venezuelan "llanos," and, if one were to insist upon priority for phytogeographic terms, *savanna* might well be used only for those grasslands of the northern part of South America which are definitely climatic rather than edaphic in origin. Interesting discussions of the *savanna* are given by MYERS (Notes on the vegetation of the Venezuelan llanos. Jour. Ecol. 21: 335-349. 1933; Savannah and forest vegetation of the interior Guiana plateau. *Op. cit.* 24: 162-184. 1936) and LANJOUW (Studies of the vegetation of the Suriname savannahs and swamps. Meded. Bot. Mus. Herb. Rijks Univ. Utrecht 33: 823-851. 1936). LANJOUW proposes the following definition of the term: "Savannahs are plains in the West Indian Islands and Northern South America covered with more or less xeromorph herbs and small shrubs and with few trees or larger shrubs."

By other students the term *savanna* is extended to include such zones as the Brazilian "campo" and the "parque mesopotámico" of northern Argentina and Uruguay. On our map three general areas are similarly marked as *savanna*: the *true savannas* of Venezuela, northern Brazil, etc., the *Uruguayan savannas,* and the *campo.*

a. *True savannas.* It is perhaps arbitrary to designate the northern savannas as "true," but historically this is correct, the term having been originated to designate the "llanos" of the Orinoco basin. These "llanos" extend along the Orinoco above its delta and well into adjacent Colombia in the drainage of the Meta and parallel rivers. A large part of the Rio Branco-Rupununi region is covered with a similar formation. The "llanos" are not open prairies or "pampas" similar to those of the United States or the Argentine, although in places there are vast areas devoid of trees. The predominant vegetation is made up of bunch-grasses (*Andropogon, Cymbopogon, Trachypogon,* etc.) and sedges, while the most ubiquitous woody plants

are *Curatella americana, Bowdichia virgilioides,* and species of *Byrsonima,* with stands of *Mauritia flexuosa* in damper spots (PL. 14).

The most striking climatic feature of this region is the long dry season of five months or more entirely without rain; during the short wet season, however, rains are heavy and much of the area is flooded, the soil often being more or less impervious. Thus the savannas of this region appear to be true climatic savannas. It is probable that many of the other regions marked as savanna on our map, scattered throughout interior Guiana and northern Brazil, Panama, and Costa Rica, are similarly true climatic savannas.

On the other hand, the savannas of northern Surinam, French Guiana, Trinidad, and possibly those of coastal and lower Amazonian Brazil appear to be edaphic in origin, there being no long dry season in these regions. LANJOUW suggests that the Surinam savannas have originated from tropical rain-forest (which surrounds them) in which the soil has become barren through continuous leaching, and that fire is an important factor in maintaining the savanna. It seems likely that the so-called savannas of many West Indian islands are similarly edaphic in origin. Our map shows extensive savannas in Cuba and Hispaniola, but actually great extents in Cuba so marked are covered with semi-deciduous forest, while the "savanna" itself is mixed with palm-forest, thorn-bush, etc., to a degree impossible to indicate on a large-scale map.

b. *Uruguayan savannas.* Uruguay, the southern part of Rio Grande do Sul, and the adjacent portion of Argentina east of the Paraná River make up a phytogeographic province which is more or less intermediate between the pampean grassland and the subtropical forest-savanna region to the north. In this region the terrain is flat and mostly grass-covered, but woody plants are often present in abundance, and the rainfall is considerably heavier than in the prairie-like region west of the Paraná and La Plata Rivers. Toward their northern border, these savannas bear an extraordinary diversity of species of numerous families, notably of the *Compositae, Leguminosae, Malvaceae, Sterculiaceae, Boraginaceae,* etc. The boundary between the *Uruguayan savannas* and the forest-savanna region to the north can be fixed only arbitrarily, the transition being very gradual.

c. *Campo.* Probably no part of South America has been the subject of more phytogeographic disagreement than the interior region covering a large part of Matto Grosso and the Brazilian states to the east. According to some writers this region is a "prairie," while others term it "savanna" and still others indicate that it is primarily occupied by xerophilous forest. Actually, it is very diverse and includes a host of associations, ranging from hygrophilous forest to grassland or semi-desert. Thus, its boundaries and its definition can be only arbitrary. The greater part of the *campo* is probably a scrub-covered or park-like grassland, with extensive tracts of nearly treeless savannas. The region has a marked dry season. Tree- and shrub-growth is probably better developed, on the whole, than in the Uruguayan-South Brazilian savannas to the south or in the Venezuelan-North Brazilian savannas to the north (PL. 15).

2. *Pampean grassland.* — The vast grasslands of eastern Argentina, bordered on the south and west by the "monte," on the north by the "chaco," and on the northeast by the savanna-like "parque mesopotámico," form an entirely flat region, without trees. The northern parts of this prairie-like region are the "pampas," which term is sometimes used for the entire phytogeographic province; other writers use the expression "plana bonariense" for the zone we designate as *pampean grassland* (PL. 16).

### III. DESERTS OR SEMI-DESERT REGIONS

1. *Coastal deserts of Pacific South America.* — In this desert zone is included a belt of country 50-100 miles wide extending from northern Peru to the south of Coquimbo, Chile, and from the sea up the west flank of the Andean highlands. Favored hills near the ocean are moistened by sea-fogs which bathe them during the winter and spring and which permit the development of the remarkable mesophytic "loma formation" in this otherwise prevailingly desert area. In the region are two of the most barren deserts in America, those of northwestern Peru and northern Chile, containing tracts which in normal years are practically rainless and devoid of higher plants. Much of the South American coastal deserts bears a very open and sparse scrub vegetation and scattered vernal herbs. Only a few native trees are known from the whole area, and these are confined to water-courses. The northern deserts have high summer temperatures. The Chilean deserts are cooler but are characterized by lower atmospheric humidity and more marked variation in daily temperature (PL. 17).

2. *Patagonian-Fuegian steppe.* — This extensive region of southern Argentina and the Fuegian portion of Chile is characterized by a temperate or cold climate, windy and very dry. The vegetation is essentially without trees and is dominated by rosette- and cushion-plants. On the west this region is bordered by the subantarctic forests of southern Chile, while to the north and northeast it is bounded by the so-called "monte" or desert scrub.

3. *Desert scrub.* — The interior portion of central and northern Argentina, locally known as the "monte," is an area with a climate as dry as that of the Patagonian steppe, but somewhat warmer and essentially without a winter season. The vegetation of this desert region is extremely xerophilous, often with low trees. Extending from the Atlantic in the southeast and the Patagonian steppe in the south and southwest, the "monte" extends northward to the "chaco" region, being flanked on the east by extensive grasslands. Toward the west and northwest, the *desert scrub* ascends lateral chains of the Andes to a considerable altitude, sometimes to 3000 meters, in which region it gives way to the Andean flora.

The *desert scrub* of northern Mexico and adjoining U. S. A. is not only similar in appearance to the "monte" of Argentina, but also shares with it a characteristic shrub, *Larrea divaricata. Larrea* is found in the parts of Mexico with minimum rainfall and is a familiar plant in western Sonora, much of Baja California, and in the intermontane plateau south into San Luis Potosi. Bordering the *desert scrub* containing *Larrea* on the intermontane plateau, particularly on the west and south, dry grasslands become a conspicuous feature, especially in broad valleys. The rough limestone country

PLATE 5. — *Riverine tropical rain-forest.* — Tab. physiogn. I of MARTIUS' *Flora Brasiliensis* ("Silva in ripa fluvii Amazonum, Caa-ygapo dicta").

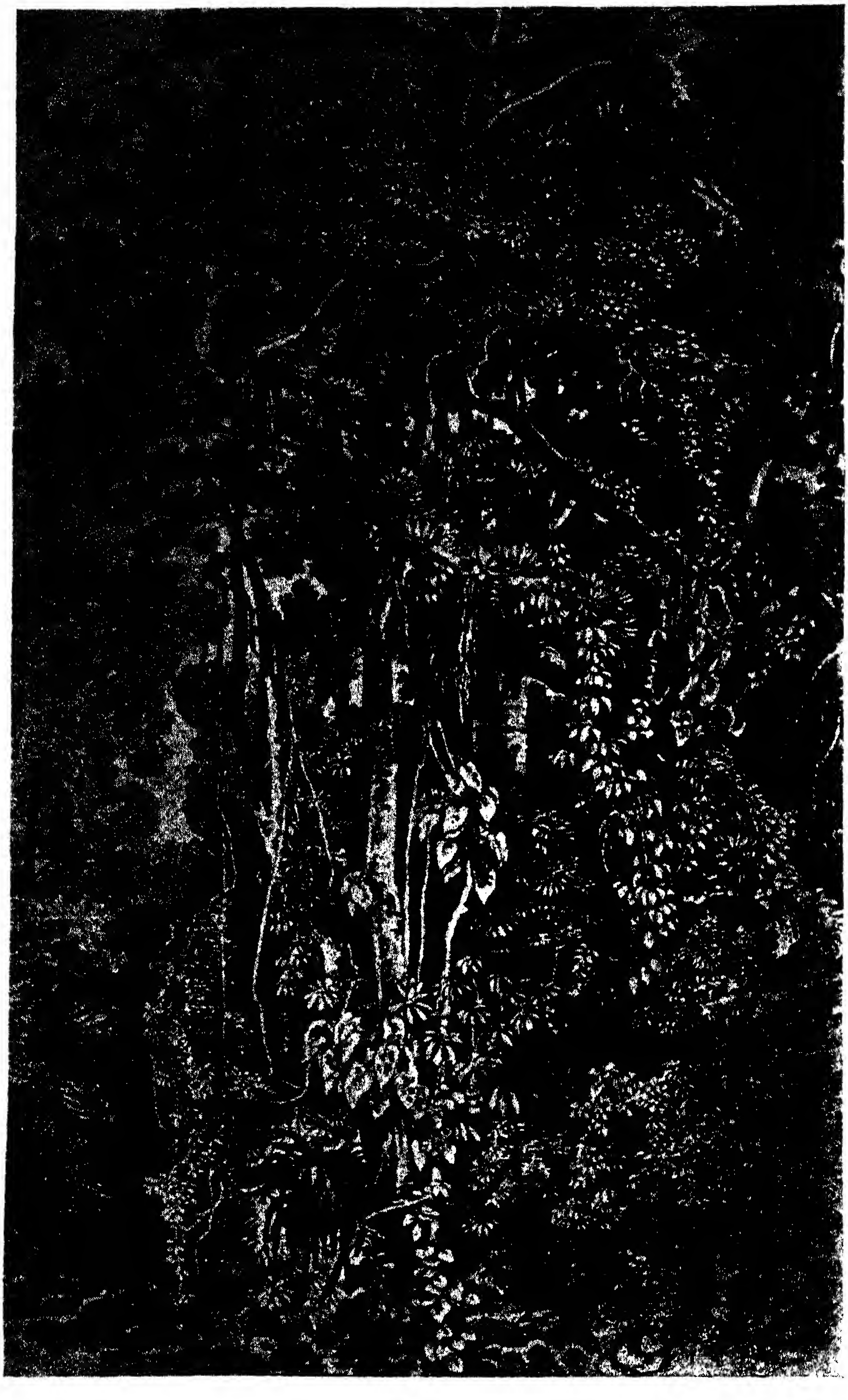


PLATE 6. — *Tropical rain-forest.* — Pl. 3 of BELLERMAN'S "Tropenbildern," Berlin, 1894 ("Laubwald aus der Quebrada de las minas bei Cumanacoa, 300'. Vorn ein grosser Stamm von *Ficus gigantea,* etwas zurück einige Stämme von *Ocotea turbacensis.* Beide sind berankt mit *Bignonien, Cissus* und *Philodendron, Sciadophyllum* und *Rhipsalis*-Arten, und bewachsen; ersterer mit *Acrosticha, Pleurothallideen* und *Anthurien,* letzterer am Grunde mit einer *Bromelie, Pitcairnia.* Im Vordergrunde links eine *Myrsinee*").

PLATE 7. — *Mexican subtropical rain-forest* ("Silva primaeva montana chinantlensis"). — The foothill vegetation in a narrow pass in the La Chinantla region, Northeastern Oaxaca, Mexico. Today the river is still crossed by a vine suspension bridge, as illustrated. Sketched by the Danish botanist and collector F. M. LIEBMANN (1813/56). After a rare lithograph by NORDAHL GROVE *(courtesy Chicago Natural History Museum)*. This was made for LIEBMANN's unfinished account of the palms of Mexico, prints were struck off, but they were never issued.

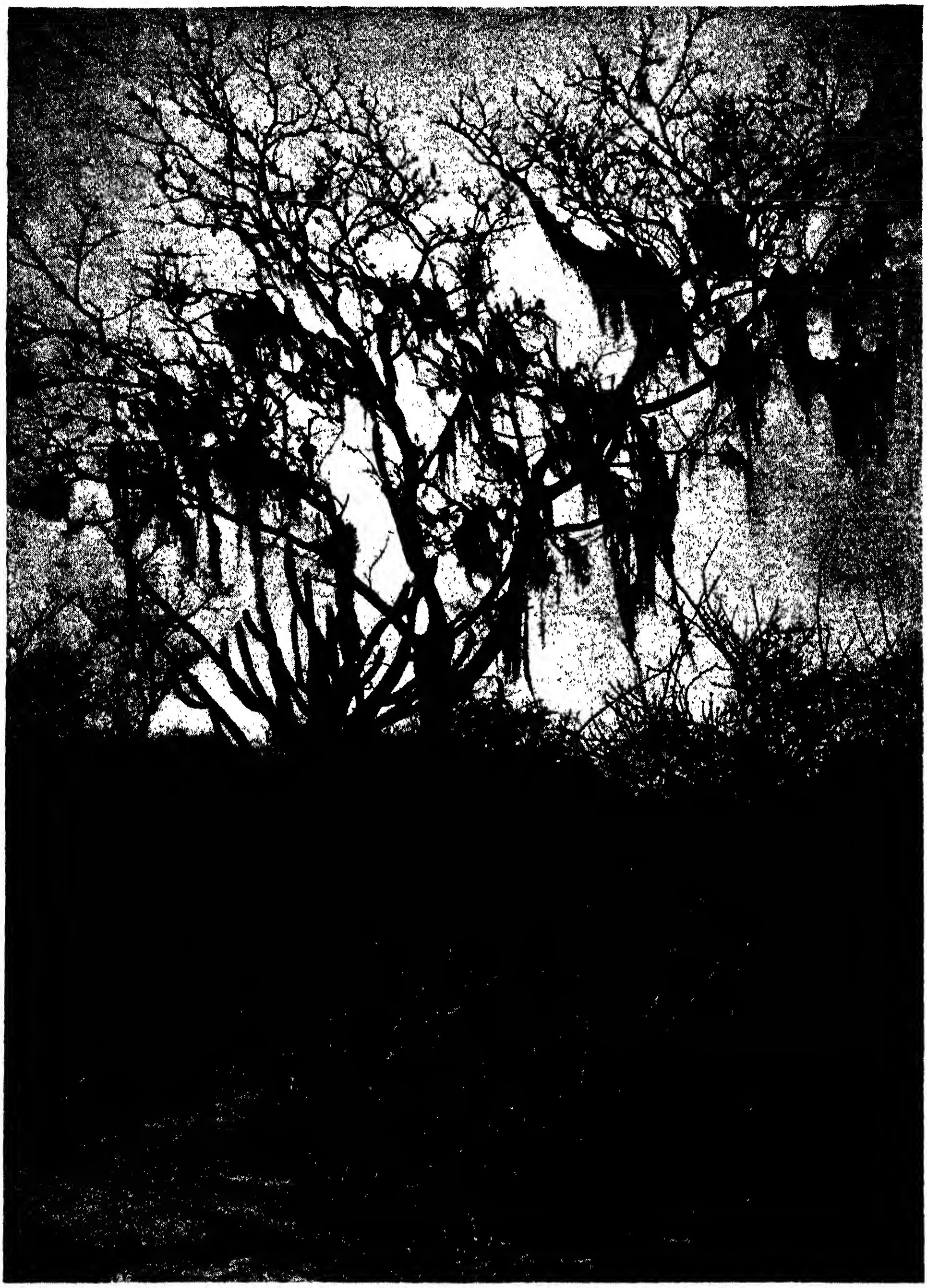


PLATE 8. — *Caatinga.* — *Mimosaceae* with epiphytic *Tillandsiae, e.g. T. usneoides,* also *Cereus catingicola,* near Calderão, Baia. — *From* E. ULE, Nordost Brasilien, Veget. Bilder VI, 3.

PLATE 9a. — *Tropical rain-forest.* — A group of Camacans in the Brazilian rain-forest (conventionalized). — *From* "Reise des Prinzen von Neuwied in Brasilien".

PLATE 9b. — *Chaco parkland.* — *From* PARODI'S "Argentine Phytographical Serie" ["The extensive Argentine territory known as the Chaco is covered by mixed vegetation where the scattered trees or woodlands alternate with fields covered by herbaceous plants among which grasses predominate. The trees best known in this section are the Red Quebracho *(Schinopsis Balansae* and *S. Lorentzii)*, Algarrobo *(Prosopis alba, P. nigra,* etc.), the Guayacan (*Caesalpinia melanocarpa*), etc. The scene presents a path crossing the woodland. To the left is the typical Palo borracho *(Chorisia)* and to the right an Algarrobo *(Prosopis algarrobilla")*].

PLATE 10. — *Chaco* (*savanna*). — Tab. physiogn. VII of MARTIUS' *Flora Brasiliensis* ("Campi generales juxta serra de Mantiqueira, prope Lorena, Prov. S. Pauli"; "Habes in parte antica ad sinistram *Callopisma perfoliatum, Gomphiam floribundam, Paspalum conjugatum* et *canescentem*, in media tabula *Paspalum eminentem* et *crianthum* et *Opuntiae* fruticem, in parte dextra *Paspalum crianthum* et *Gomphrenam officinalem*. Palma, quae in fundo emicat ad sinistram, est *Acrocomia sclerocarpa*").

Plate 11. — *Paraná pine forest.* — *Araucaria brasiliana* in the State of Paraná (Brazil). — *From* H. Schenck's "Südbrasilien", Veget. Bilder I, 1.

PLATE 12*a*. — *Tropical rain-forest.* — Cutting a way along a tributary of the Rio Doce. — *From* "Reise des Prinzen von Neuwied in Brasilien".

PLATE 12*b*. — ***South Brazilian forest and savanna zone.*** — **Araucarias in the Serra-Ouro-Branco (Minas Gerais, Brazil). — *From* RUGENDA's "Reise in Brasilien" (1836).**

PLATE 13. — *Palm forest.* — Tab. physiogn. LIV of MARTIUS' *Flora Brasiliensis* ("Fontes Fluvii Paraguay"). The palm is *Copernicia australis* (Carandá palm).

**Plate 14.** — *Colombian llanos.* — ("Une corrida de bétail dans les Llanos, dessin de Riou, d'après un croquis de M. André"). — *From* E. André's "L'Amérique Équinoxiale".


Plate 15. — *The campo.* — Swampy, periodically inundated, savannas in the Matto Grosso (Brazil). The ox is often used for transport in this and other parts of tropical America. — *Courtesy Rev. Bras. Geogr.*

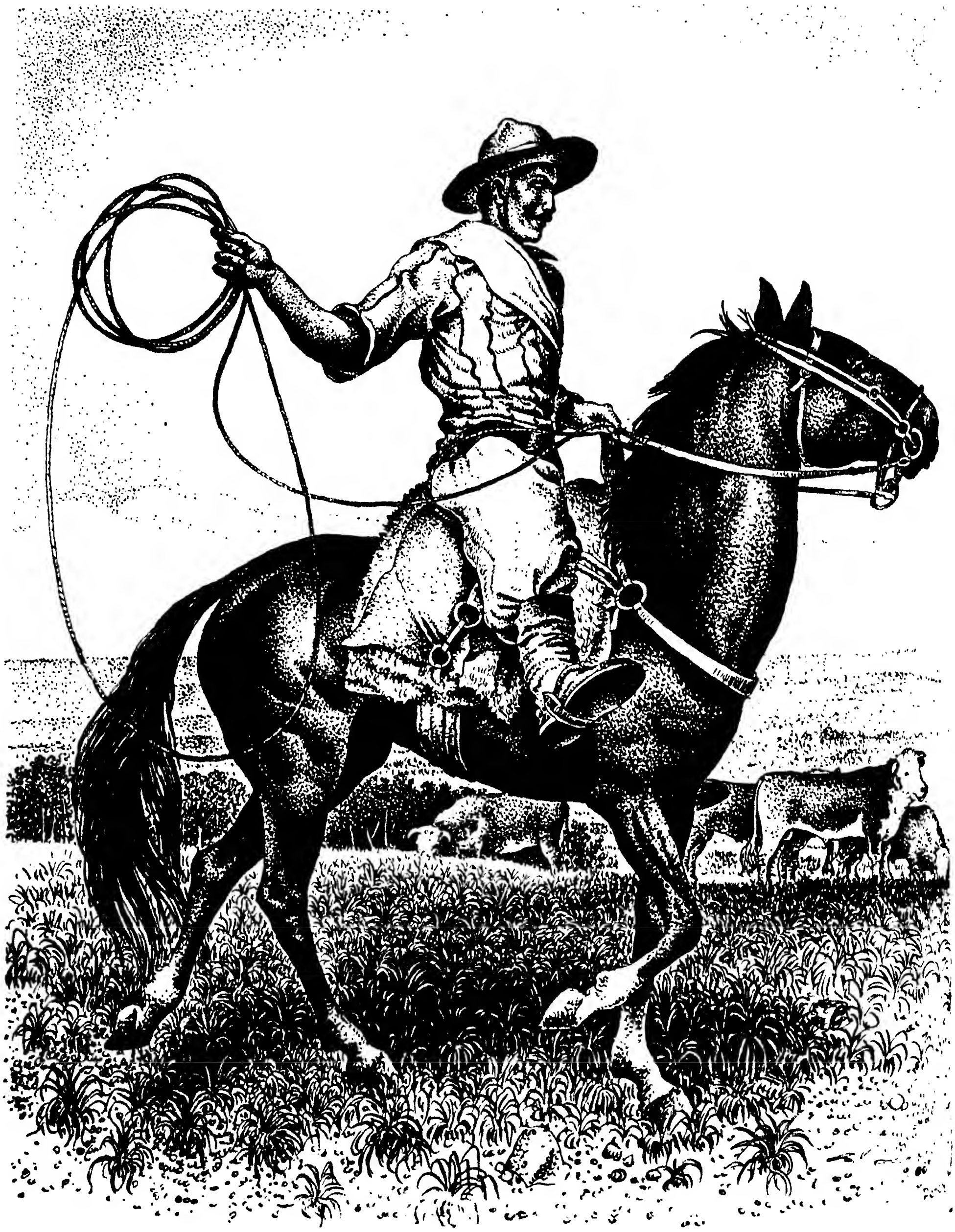


Plate 16. — *Pampean grassland.* — O Gaucho ("the cowboy") in the campos in the Rio Grande do Sul territory (Southeastern Brazil and Uruguay). — *Courtesy Rev. Bras. Geogr.*

PLATE 17. — *Coastal deserts of Pacific South America.* — Peru-Paramongo-Inca Ruins. — *Courtesy Grace Log.*

PLATE 18. — *Desert scrub of northern Mexico.* — In the foreground: *Agave ferox* and *Hechtia*; at top of the hill: *Echinocactus*; behind the man: different species of *Dasylirion*; Cañada Ixtapam near Tehuacan, Puebla. — *From* KARSTEN und STAHL's "Mexican. Cacteen," Veget. Bilder I, 8.

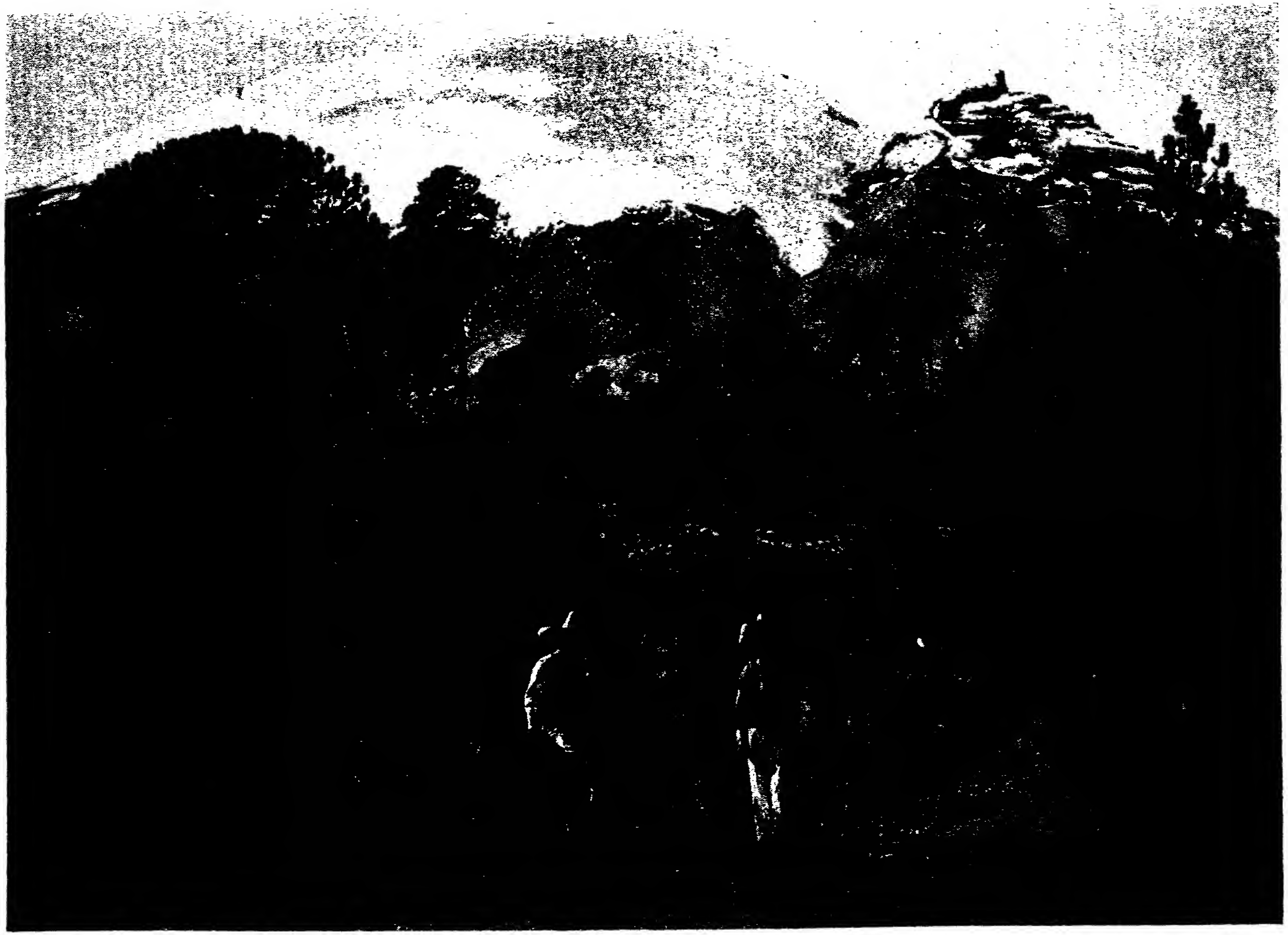


PLATE 19. — *Montane zone of Mexico.* — Forest limit at the Popocatepetl (*Pinus Hartwegii* and *Senecio calcarius*). — *From* C. A. PURPUS' "Mexic. Hochgipfel", Veget. Bilder V, 8.

PLATE 20*a*. — *Páramos of the northern Andes.* — Páramo de los Conejos (Venezuela), showing a stand of *Espeletia*. — *Courtesy Señor* A. SPINETTI DINI.

PLATE 20*b*. — *Puna vegetation of the southern Andes.* — Highlands of Oruro. Cactuses and white llama in foreground. — *Courtesy Pan American Union.*

south of the range of *Larrea,* where rainfall is slightly more abundant but the soil excessively well drained, has *desert scrub* vegetation containing some of the species found with *Larrea* farther north but in the main made up of species and even genera more characteristic of the margins of the central plateau. The dry grasslands tend to be on volcanic terrains or valley alluvium, and the scrub south of the range of *Larrea* tends to be confined to dry limestone (PL. 18).

Perhaps to be included in the Mexican *desert scrub* are some of the formations on the south margin of the central plateau in adjoining parts of Puebla and Oaxaca, such as the Tehuacan area. Most of the arid depression south of the central plateau, largely composed of the basin of the Rio Balsas, seems to consist of transitional phases between thorn forest and tropical deciduous forest.

4. *Transitional vegetation of central Chile.* — The area so designated is a region with a Mediterranean type of climate, with cool moderately rainy winters and dry warm summers, and with a rich herbaceous spring flora and many sclerophyllous evergreen shrubs. In climate and flora this region is transitional between the wet subantarctic forests and the desert areas of northern Chile. Presumably this results from the extension northward during the winter months of the rain-bringing Westerlies. The southern boundary of this zone, between Concepcion on the coast and the Cordillera de Chillan, is moderately well defined; its northern limit is vague but is usually accepted as cutting across the southern portions of the Province of Coquimbo. The area contains the most populated parts of Chile.

5. *California chaparral.* — On the Pacific slopes of northwestern Baja California, the very distinctive plant formation known as *California chaparral* extends across the Mexican boundary and reaches its southern limit. The formation consists of dense growths of microphyllous and sclerophyllous evergreen shrubs, commonly forming almost impenetrable thickets on slopes. Various shrubby members of *Quercus, Ceanothus,* and *Arctostaphylos* are characteristic elements in this flora. As with the flora of central Chile, it has developed in a region of hot dry summers and mild moderately rainy winters.

### IV. MONTANE ZONE

The regions thus indicated on our map are occupied by a diversity of associations, but each vegetational type occupies such a narrow or otherwise limited area that further division would be possible only on a series of small-scale maps. In these montane regions, of course, altitude is the most obvious factor governing vegetational zonation; of nearly equal importance are rainfall, soil conditions, local topography, etc. In addition, the origins of the floras of various montane regions are to be considered; in Central America a large part of the flora shows boreal relationships, in the southern Andes there are large austral elements, while in the northern Andes we find a high percentage of the flora to have been probably derived from migrating lowland elements of adjacent regions. Throughout the American Cordillera we observe a mixture of boreal and austral elements in the vegetation, this chain having been one of the "trans-tropical highland bridges" permitting a mixing of temperate elements of the northern and southern hemispheres. Consequently, transitions between adjacent areas are gradual and divisions must be arbitrary. For convenience, we discuss the highland regions under three headings: (1) Mexico, Central America, and the larger West Indies, (2) the northern Andes, of Venezuela, Colombia, Ecuador, and northern Peru, and (3) the southern Andes, of southern Peru, Bolivia, and northern Chile and Argentina.

One is not entirely justified in excluding all the non-Andean mountainous parts of South America from a *montane zone,* but for convenience we group under this heading only those areas where the vegetation is more or less temperate in appearance and to a certain degree in origin. The Pacaraima Mountains of the Venezuela-Brazil boundary rise out of the rain-forest to altitudes exceeding 2500 meters, and the flora of their summits is distinctly temperate in aspect if not in origin of floral elements. However, the area covered by these mountains is small and the region is scarcely known botanically; for the purpose of a generalized map the region is best excluded from a *montane zone.* Similarly, the mountains of southeastern Brazil are floristically to be considered with the coastal rain-forest and the adjacent "campo."

1. *Mexico, Central America, and the larger West Indies.* — The temperate areas of Mexico include the fine coniferous forests of the eastern and western Sierra Madre and those of central and southern Mexico, and also the zone of vegetation next below the coniferous forests, in which a variety of arborescent and shrubby oaks are characteristic elements. It is conventional to include the dry valleys of central Mexico in temperate areas. These valleys, the most densely populated in Mexico, are rich in grass and other herbaceous plants and their lower slopes bear various xerophytes. They have the characteristics of the transition between desert and oak belts to be observed along the desert borders in northern Mexico (PL. 19).

Well developed temperate forests, characterized by oak and pine, are found in the central highlands of Guatemala and Honduras and south to northern Nicaragua. Many elements in the temperate flora of southern Mexico and Central America appear to have migrated from northern centers. South of Nicaragua the temperate flora appears to have more affinity with that of the northern Andes in South America.

Considerable areas in which species of pine are dominant occur in Cuba and Hispaniola; these highland regions should perhaps be placed in our *montane zone.*

2. *Northern Andes.* — The vegetation of the northern Andes may be discussed under the *temperate zone* and the *páramo.*

The *temperate zone* extends from the upper limit of the subtropical forest, usually 1800-2500 m., up to the timber line, of which the altitude is variable in different localities but in general varies from 3200 to 3800 m. On the Amazonian slopes the temperate zone (sometimes known as the "ceja de la montaña") is forest-covered and receives a heavy rainfall. Epiphytic vegetation is often thick and in many places the trees are covered with orchids, bromeliads, and bryophytes. The trees become reduced in stature and gnarled toward the upper limits. They are often of the same genera as trees of the subtropical forest. In addition there are boreal ele-

ments, such as *Quercus* (in Colombia), which one often sees in a strange oak-palm consociation. It is a region of tree-ferns, epiphytic filmy-ferns, dense and varied underbrush, and bright-flowered ericaceous and gesneriaceous shrubs.

On the Pacific and Caribbean Andean slopes of Venezuela, Colombia, and Ecuador, essentially the same conditions and types of vegetation occur as described above. In Peru, however, the Pacific Andean slopes are much drier than the Amazonian slopes and support no such rich forest. The transition from the desert coastal regions to the higher montane vegetation is often marked by grass steppes, which are green only in the rainy season, or by a shrub-herb zone which presents a brightly colored aspect during the few wet months.

The areas above timber line, in the northern Andes known as *páramos,* usually have a very wet climate, being subject to rains and heavy fogs throughout the year. These wet alpine meadows extend south to northern Peru, where they are known as "jalcas." Farther south this zone is replaced by the drier *puna.* The characteristic *páramo* vegetation consists of herbaceous plants with thick roots and coriaceous leaves. Extensive moors, dominated by grasses and such cushion plants as species of *Distichia, Erigeron,* and *Werneria,* alternate with meadows of bright-flowered species of *Hypericum, Geranium, Gentiana, Lupinus,* etc. In northern Ecuador, Colombia, and Venezuela, the *páramos* are characterized by many species of the endemic composite genus *Espeletia* (PL. 20*a*).

The *páramos* cover vast expanses of the rolling plateau country of the northern Andes. Their upper limit in places lies just below the line of perpetual snow. The higher *páramos* are often bleak and rocky barrens, but a few species, usually grasses or sedges, ascend essentially to the snow line. These high north Andean slopes have much in common with the southern *puna.* Throughout the *páramo* region, of course, projections of bare rock and other topographic features preclude the development of vegetation.

A transitional zone between *páramo* and temperate forest is locally known as the "paramillo." This supports a mixture of alpine herbs and shrubs with dwarf trees of the lower elevations. Occasionally typical *páramo* plants, such as *Espeletia neriifolia* in Venezuela, may descend to as low an elevation as 1500 m.

The highlands of Costa Rica and western Panama are somewhat similar to those above described, while floristically they appear to have much in common with the highlands of Colombia.

3. *Southern Andes.* — Southward from the equator along the Andean highlands, the moisture received on the higher slopes decreases and becomes seasonal, and there is an accompanying change in the vegetation. The high intermontane valleys of central and southern Peru support dry grasslands and in many places sub-xerophilous shrubs and trees, many of them deciduous during the winter. These sub-xerophilous formations are replaced by the so-called "ceja de la montaña" as the valleys descend toward the east and by the *puna* flora as altitudes increase. They represent a dry temperate vegetation which may be traced along the margins of the forests surrounding the Amazon basin as far south as the eastern margin of the Bolivian plateau (PL. 20*b*).

The high altitudes of central and southern Peru have a remarkable alpine vegetation. This *puna* flora also dominates large areas on the tableland in western and southern Bolivia, northern Chile, and northwestern Argentina. It consists of a great variety of remarkable cushion-, rosette-, and caespitose herbs and shrubs. South of Peru the *puna* becomes very dry. The precipitation is scanty, mostly in the form of a few winter snowfalls, the atmosphere very dry, temperature changes extreme, and the soil frequently charged with a great variety of mineral salts. In Bolivia and adjacent Chile most of the vegetation and practically all of the upright bushes are found along watercourses, in valleys about saline lakes, or elsewhere where some soil moisture accumulates. Elements of the *puna* flora extend southward as the high montane flora along the Chile-Argentina Andes to about Aconcagua. South of this point its elements diminish and mingle with northern elements of the flora of the Patagonian steppe which occupy Andean crests from Chillan southward.

Below the *puna* and above the coastal deserts on the western slope of the Andes from southern Peru south along the margins of the Bolivian plateau, there is a well marked belt in which thickets of small shrubs, many of them resinous and evergreen, and plains with scattered bunchgrass make up a distinctive formation. This so-called "tola" belt can be classed either as desert or as marginal to the dry *puna.* Because of its floristic composition it seems best associated with the *puna.*

### V. MARITIME OR LITTORAL ZONE

In preparing the accompanying map, we have made no attempt to indicate the narrow maritime zone, which is not appreciable in size on a large-scale map, although it is of wide geographic distribution and of considerable local importance. This zone occupies essentially the entire coast-line of tropical American countries in wet regions. The outer part of the maritime zone consists of lower plants and a few vascular plants such as *Ruppia, Najas,* etc. The inner part consists in the main of mangrove swamps made up of species of *Rhizophora, Avicennia, Conocarpus, Bucida,* etc. Where open beaches occur they are often occupied by species of *Ipomoea* and various grasses, while mud-banks are sometimes extensive and support a cover of *Acrostichum aureum* and *Eleocharis* and other sedges. The mangrove formation and the characteristic beach flora of the American tropics are found in the West Indies and on the Caribbean coasts, and on the Atlantic coast south to southern Brazil. On the Pacific coast this type of littoral vegetation occurs from southern Baja California and well up the Gulf of California south to southern Ecuador.

ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

F. R. FOSBERG: **Principal Economic Plants of Tropical America:** — An adequate understanding of the economic structure of Latin America and its relation to that of all other countries must be based on the realization that plants are fundamentally important in the lives and activities of most of the people of Latin America. This is, of course, true of most other regions also.

Agriculture and related occupations, including forestry and the utilization of forests are, and certainly in the near future will continue to be, the mainstays of the economy of this part of the world. Mining is, of course, locally very important, but occupies only a small proportion of the population. Manufacturing, if it ever becomes widely important, is a thing of the more distant future.

Several things tend to favor this. In addition to the agricultural background of the people and the advantage of a long growing season over most of the region, another factor is of great consequence. Despite the long history of agricultural activity and land misuse in large portions of Latin America, the soils in many parts have not been depleted to nearly the extent that they have generally in North America, Africa, and Asia. This may well be due to the fortunate sparseness of the population in most places. In Europe and the United States the tremendous importance of proper treatment of the soil is now being realized, and efficient methods of soil conservation are being worked out. If the agriculturists of Latin America can be shown the vital necessity of using these practices, there is no reason why this area should not continue for all time as one of the greatest agricultural regions of the earth. This seems true in spite of the fact that in some localities where frequent burning is practiced or where steep slopes are farmed irreparable damage has already been done.

Still another factor is the great number of useful plants which have had their development in Latin America, together with the number growing there which have potential economic importance.

To understand a region whose basic resources are plants it is obviously necessary to know the plants. This does not imply simply a passing familiarity or tourist's knowledge, but a thorough and organized fund of information about all of the plants and all aspects of them. Again, this does not mean only the so-called useful plants, those which are economically important at present, but all of the plants, both native and introduced. Species that were, a hundred years ago, unknown or merely botanical curiosities, for example the various rubber-yielding species, are now of such consequence as to determine the course of international politics and even war.

Only a beginning has been made in the direction of a knowledge of the scores of thousands of species present in Latin America. There are not even floras available covering most parts of this area. Much, however, has been written about a few of the more important economic species. An attempt is made below to give a few general remarks about these species, with references to some of the more important literature on them. It should be understood that by no means all of the known economic species are mentioned, and that the probability is that plant resources now considered unimportant or which are still undiscovered will ultimately prove to be of more significance than all of the present commercial species combined.

Because of the similarity of the problems and the identity of most of the plants concerned with those well known in Europe and temperate North America, those portions of Argentina and Chile which lie south of the subtropical belt are not included in the following discussion. Visitors to these countries from the North Temperate Zone should find themselves quite at home if they are familiar with agriculture in their own parts of the world.

The purpose of this article being, in part, to direct visiting students to literature that will help them understand what they see in Latin America, only those species which the visitor is likely to come in contact with, or to which his attention should be drawn, are mentioned. Every observant traveller will soon realize the wealth of plants which are at present of only local importance on which little or no scientific literature is available.

The bibliographic material in this article is, of course, not intended to be complete, but only suggestive, and to serve as a starting point. Most of the books and articles cited contain bibliographies which will enable the reader to get a more comprehensive view of the literature on any of the subjects treated. I have not carefully examined all of the publications cited. Some may contain little of value.

A few general and bibliographic works are the following: AMES, O., The Economic Annuals, 1-153, Cambridge, 1939.—BARRETT, O. W., The Tropical Crops, 1-445, New York, 1928.—BROCADET, A. P., Plantes Utiles du Brésil, 1-144, Paris, 1921.—CAPUS, G., Les Produits Coloniaux d'Origine Végétale, 1-499, Paris, 1930. — CHEESMAN, E. E., Trop. Agr. Trin. 16:101-107, 1939. — COOK, O. F., and COLLINS, G. N., Contr. U. S. Nat. Herb. 8:57-269, 1903. — DECKER, J. S., Aspectos Biologicos da Flora Brasileira, 1-640, São Leopoldo, 1936. — FREEMAN, W. G., and WILLIAMS, R. O., The Useful and Ornamental Plants of Trinidad and Tobago, 1-198, Port-of-Spain, 1927.—GILL, T., Tropical Forests of the Caribbean, 1-317, Washington, 1931. — HILL, A. F., Economic Botany, 1-592, New YORK, 1937. — HOEHNE, F. C., A Flora do Brasil, in Recens. do Bras. 1920, 1:99-230, 1922. — HUNTINGTON, E., Bull. Geogr. Soc. Phila. 17:83-97, 1919. — Intern. Inst. Agr., Bibliography of Tropical Agriculture, 1931-1939. Rome, 1932-1940. — KRISCHE, P., Ernähr. Pflanze 32 (22), map, 1936. — KUNTZE, H. U., Mitt. Biol. Reichs, Land- u. Forstwirtsch. 56:1-32, 1938 (a selected bibliography). — LE COINTE, P., Amazonia Brasileira 3:1-486, 1934. — MACMILLAN, H. F., Tropical Gardening and Planting, ed. 4, 1-560, London, 1935. — PÉREZ ARBELÁEZ, E., Plantas Utiles de Colombia I, 1-172. Bogota, 1936. — PITTIER, H. F., Plantas Usuales de Venezuela, 1-458, Caracas, 1926; suppl. 1-129, Caracas, 1939; Ensayo sobre los plantas usuales de Costa Rica, 1-176, Washington, 1908. — SPRECHER VON BERNEGG, A., Tropische und Subtropische Weltwirtschaftspflanzen, etc., 1:1-438; 2:1-339; 3(1):1-264; 3(2):1-286; 3(3):1-432, Stuttgart, 1929-1936. — VERRILL, A. H., Foods America Gave the World, 1-289, Boston, 1937. — WILCOX, E. V., Tropical Agriculture, 1-373, New York, 1916. — ZON, R., and SPARHAWK, W. N., Forest Resources of the World, II: 495-808, New York, 1923. — JONES, C. F., Econ. Geogr. 4:1-30, 159-186; 6:1-36, 1930.

I am greatly indebted, for many valuable suggestions, to WILSON POPENOE, of the United Fruit Company, and to J. H. KEMPTON, B. Y. MORRISON, C. O. ERLANSON, W. A. ARCHER, and R. H. ALLEE and his staff, of the U. S. Department of Agriculture. Without the unique botanical catalog of the U. S. Department of Agriculture Library, the bibliographic portions of this article would have been impossible.

*FOOD PLANTS (NATIVE)*: — At the time of the conquest of the Americas by Europeans, the Inca, Maya, Aztec, and other well developed American cultures possessed a surprising number of domesticated food plants, some of which, maize, peanuts, potatoes, squashes and pumpkins, etc., have since spread over the earth and assumed a major position in the world's food supply. Some of these had been

cultivated for so long, and modified so much, that their wild ancestors are now unknown, either because of extinction or the profound modification of their cultivated descendants. In some of them, even the modern horticulturists have failed to produce any significant improvement over the major varieties grown by the Indians. Others, apparently just as desirable, have for no obvious reason remained of only local importance.

*Maize*, or *Indian corn* (*Zea mays*), has become one of the world's most important agricultural plants. Although shelves of literature have been written about the subject, its origin is still a mystery. Certainly its home is somewhere in tropical America. It has been, and is today, one of the mainstays of life in many parts of the American Tropics, although at present its commercial production centers in temperate North America. From the standpoint of the Temperate Zone corn breeder, South American varieties are of some importance as sources of certain desirable characters, such as the cold tolerance of the high Andean forms. (WEATHERWAX, P., The Story of the Maize Plant, Chicago, 1923; Univ. N. Mex. Bull. 296: 11-18, 1936. — COLLINS, G. N., Ann. Rept. Amer. Hist. Assoc. (1919), 1: 409-429, 1923; Bull. Torr. Club 57: 199-210, 1930. — KEMPTON, J. H., Jour. Hered. 17: 32-51, 1926; Old and New Plant Lore 11: 319-349, 1931; Univ. N. Mex. Bull. 296: 19-28, 1936. — MANGELSDORF, P. C., and REEVES, R. G., The Origin of Indian Corn and its Relatives. Tex. Agr. Exp. Sta. Bull. 574: 1-315, 1939. — WALLACE, H. A. and BRESSMAN, E. N., Corn and Corn Growing, ed. 4, 1-436, New York, 1937).

*Beans* (various species of *Phaseolus*) are second only to maize in the domestic food economy of Latin America. Again, their culture has spread to temperate countries where they have become an important article of commerce. As with corn, those interested in the improvement of bean varieties look to tropical American varieties for desirable traits to be added to the northern forms. In Latin America, production is largely by small scale methods very widely practiced. Beans also were apparently very important in the food supply of the aborigines in pre-European days. (DENAIFFE, C., Les Haricots, 1-493, Paris, 1906. — GUARDIOLA, J., El Cultivo del Frijol, 1-131, Mexico, 1921. — VIERRA SOUTO, P., Cultura dos Feijoes, etc., ed. 3, 1-29, Rio de Janeiro, 1918). Three of the major bean species of the world are of American origin and are important in America, the kidney bean (*Phaseolus vulgaris*) (GIBAULT, G., Jour. Soc. Nat. Hist. de France 18: 658-673, 1896), the various forms of lima beans (*Phaseolus lunatus*) (BAILEY, L. H., Gentes Herb. 4: 336-341, 1940), and the less well-known tepary bean (*Phaseolus acutifolius* var. *latifolius*) of the Southwestern Indians (FREEMAN, G. F., Bot. Gaz. 56: 395-417, 1913).

Two unusual cereals, *quinoa* (*Chenopodium quinoa*), and *quihuicha* or *Inca-pachaqui* (*Amaranthus caudatus* or *A. edulis*) have been grown in the Andean highlands since prehistoric times. They have never assumed any real importance in other parts of the world. (ALBES, Bull. Pan Am. Un. 47: 51-61, 1918. — MINTZER, M. J., Bol. Mens. Min. Agr. Argent. 34 (1): 59-77, 1933. — SAFFORD, W. E., Proc. Int. Congr. Americanists 19: 286-297, 1917. — HERRERA, F. L., Rev. Mus. Nac. Lima 9: 229-239, 1940). A similar cereal, *huauhtli* (*Chenopodium nuttalliae*) was used by the ancient Aztecs and is still used in modern Mexico. The plants of this are also used as greens. (SAFFORD, W. E., Jour. Wash. Acad. 8: 521-527, 1918).

*Cassava* (*Manihot esculenta*), also called *yuca* or *mandioca*, is one of the widespread native food plants. It is used chiefly as a cooked starchy vegetable and in the form of cassava flour, and is exported to the United States for use as food in the form of tapioca and for paper sizing. Two forms of the plant are cultivated, one of which has a poisonous juice which must be squeezed out. This juice, boiled to rid it of its poisonous qualities and to concentrate it, forms the *cassareep* of the Caribbean region, widely used as a condiment and the basis of some of the meat sauces used in Europe and America. The culture of cassava has spread to all tropical countries, and commercial production has become very important in the Old World Tropics, especially the East Indies. (BURKHILL, I. H., Agr. Ledg. 123-148, 1904. — HUBERT, P., Le Manioc, 1-368, Paris, 1910. — BRANDÃO SOBRINHO, J., Mandioca. 1-164, São Paulo, 1916. — REGNAUDIN, A., Le Manioc, Culture, Industrie. 1-103, Paris, 1932).

The *sweet potato* (*Ipomoea batatas*), considered indigenous to the New World, but widely distributed in Polynesia in pre-European times, is now an important food crop in all warm countries. Numerous horticultural varieties differing in color, shape, consistency, and culinary characteristics are found. This is a root crop which is widely sold in temperate markets, and promises to be used more and more both as food and as a source of commercial starch. The sweet potato has several insect pests which may be serious limiting factors to extensive tropical culture unless they can be controlled. (GOTH. B. H. A., The Sweet Potato. Contr. Bot. Lab. Univ. of Pa. 4: 1-104, 1911. — BONDAR, G., Bol. Lab. Path. Veg. Baía 10: 1-44, 1931. — HAND, T. E., and COCKERHAM, K. L., The Sweet Potato; a Handbook for the Practical Grower. 1-261, New York, 1921).

The *potato* (*Solanum tuberosum*) is familiar to everyone, and is one of the most widely grown crops in temperate climates. Perhaps less familiar is the fact that its culture originated with the peoples of the Andes, at altitudes which have a temperate or cold climate, even in the Tropics. Also less familiar is the fact that in the Andes are many types of potatoes under domestication which, though very useful as food, are totally unknown in markets in other parts of the world. Wild species of *Solanum* closely related to the potato are found in the Cordilleran and West Coast regions from Arizona to the southern Andes which in the future may be of utmost importance to potato breeders. (MCINTOSH, T. P., The Potato, its History, Varieties, Culture and Diseases 1-264, 1927. — STUART, W., The Potato; its Culture, Uses, History, and Classification, 1-508, Philadelphia, 1937. — BUKASOV, S. M., The Potatoes of South America and their Breeding Possibilities, 1-192, Leningrad, 1933; Physis 18: 41-46, 1939; Rev. Arg. Agron. 8: 83-104, 1941. — REDDICK, D., Phytopath. 20: 987-991, 1930; Am. Pot. Jour. 14: 205-210, 1937).

Other native root crops, mostly of local or domestic importance in Tropical America, are the *yautia* (*Xanthosoma sagittifolia*, etc.), an

aroid with a delicious edible corm, which is widely used in the Caribbean region, and whose culture has spread to other tropical regions. (LUGO, F. O., Rev. Agr. Puerto Rico 23: 109-112, 1929.—ROIG Y MESA, J. T., Est. Exp. Agron. Cuba Bull. 21: 3-12, 1913.—SOBRINHO, V., Chacaras e Quintaes 51: 345-349, 1935); the true *yams* (several species of *Dioscorea*), vines bearing edible tubers which are widely used as food in all tropical countries (*D. alata*, an Asiatic species, is apparently the most usually cultivated, though many species are edible) (WILLIAMS, R. O., Bull. Dept. Agr. Trin. & Tob. 21: 1-26, 1925.—NOTER, R. DE, Les Ignames et leur culture dans les cinq Parties du Monde, 1-65, Paris, 1914.—YOUNG, R. A., Hacienda 19: 181-185, 1924); the *leren* (*Calathea allouia*) and the *anyu* or *cubio* (*Tropaeolum tuberosum*), two root vegetables cultivated in Peru since ancient times which, if they could be successfully introduced to the Temperate Zone consumer, might possibly become articles of commerce; the *ullucos* or *papa-lisa* (*Ullucus tuberosus*) which is grown as a garden vegetable at high altitudes in the Andes; and the *arracacha* (*Arracacia xanthorhiza*) widespread in South America and the Caribbean, whose root has a combination of the flavors of celery, carrots, and parsnips. (BOIS, D. G. J. M., Bull. Soc. Nat. Accl. France 51: 116-117, 1904. —CLAES, F., Gard. Chron. III, 95: 236, 1934).

*Squashes* and *pumpkins* (*Cucurbita maxima*, *C. moschata*, *C. pepo*) are a varied assortment of vegetables which were brought under domestication by the aborigines of tropical America and which in pre-Columbian times had spread almost throughout the two continents. Since then they have established an important place for themselves in the horticulture and food supply of the world. Reasonably constant in their vegetative characters, these plants present a bewildering array of kinds of fruits. Apparently most of the major types were in existence in prehistoric times, but there seems no end to the amount of minor variation in fruit size, shape, and quality in most of these. Cultivation is exceedingly widespread, but mostly on a very small scale. (CASTETTER, E. F., Iowa Agr. Exp. Sta. Bull. 244: 1-135, 1927.—GANDARA, G., Mem. y Rev. Soc. Ant. Alzate 53: 209-230, 1934.—ZHITENEVA, N., Trudy Prikl. Bot. Gen. i Selek. 23: 157-207, 343-356, 1930.—DARRAGH, W. H., Agr. Gaz. N. S. W. 40: 868-872, 1929.—BOIS, D., Bull. Soc. Bot. France 71: 91-93, 1924).

The *chayote* (*Sechium edule*) is another squash-like fruit, but with only one large seed. It is widely cultivated in the Tropics, where the fruits, as well as the starchy tubers, are important sources of food. It promises, eventually, to become an important item in the menus of peoples in the Temperate Zone, but as yet it is mainly a curiosity. (HOOVER, L. G., U. S. D. A. Cir. 286: 1-11, 1923.—TONTINE, M. G., Rev. Hort. 108: 234-239, 1936.—YOUNG, R. A., Nat. Hort. Mag. 12: 337-342, 1933).

The *tomato* (*Solanum lycopersicum*) has, in a few generations, come from a position as an obscure tropical fruit, distrusted as a poisonous nightshade by northern peoples, to be one of the most widely used fruits, raw in salads and as a canned vegetable. Its original home, and the habitat of its wild relatives, is the west coast of South America. The cherry tomato, the small-fruited, presumed wild ancestral type, is now widely distributed as a tropical weed. (MULLER, C. H., U. S. D. A. Misc. Pub. 382: 1-29, 1940; Nat. Hort. Mag. 19: 157-160, 1940.—MOORE, J. A., Mo. Bot. Gard. Bull. 23: 134-138, 1935).

The *peanut* (*Arachis hypogaea*) is a plant native to South America, but which has spread to other parts of the world and become so much a part of the culture that its actual place of origin was a matter of doubt until recently. It has now been shown that the native home of the genus *Arachis* is largely in the Paraná River drainage, in Paraguay, Brazil, and Argentina. *A. hypogaea* is considered by AMES to be a derivative of some perennial wild species, and not known, itself, in the wild state. A number of perennial species of *Arachis* are in local cultivation in South America, some of which may be superior in certain respects to the species ordinarily cultivated. (CHEVALIER, A., Rev. Bot. Appl. 9: 97-102, 190-197, 1929; Rev. de Bot. Appl. Agr. Trop. 13: 1-100, 1933; 14: 1-300, 1934; 16: 1-200, 1936.—BADAMI, V., Journ. Mysore Agr. and Exp. Union 15: 141-154, 1935. —HOEHNE, F. C., Flora Brasilica 25 (2): 3-20, 1940).

*Cashews* (*Anacardium occidentale*) occur both cultivated and wild in many parts of tropical America. The so-called fruit, the enlarged fleshy pedicel, is eaten locally, raw, cooked, or made into wine. The seeds are the cashew nuts which are imported in large quantities into the United States where they are a familiar delicacy, eaten roasted or made into confections. Recently this supply has come almost entirely from plantations in tropical Asia. (GRANATO, L., Bol. Agr. São Paulo 14: 107-122, 1913.—LUDOWYK, H., Trop. Agr. 69: 43-46. 1927.—PIEDRAHITO P., F. A., Rev. Inst. Def. Cafe Costa Rica 11: 122-126, 1941).

*Brazil nuts* (*Bertholletia excelsa*) are a very important export from Brazil to the United States. They are harvested from wild trees in the Amazonian forests, as the tree is not cultivated to any extent. The tree grows to a great height, and the large woody capsules containing the nuts are allowed to fall to the ground. The seeds are among the best of the commercial nuts, and are a familiar article in American markets. (SCHREIBER, W. R., Agr. in the Americas, 2: 72-74, 1942.—Anon., A Exploração de Castanha do Pará. 1-70, Rio de Janeiro, 1929.—NEVES, C. A. DAS, Revista Agr. (Piracicaba) 13: 463-476, 1938.—YOUNG, W. J., Pomona Coll. Jour. Econ. Bot. 1: 122-127, 1911; Bot. Gaz. 52: 226-231, 1911). The related *paradise nuts* (*Lecythis zabucajo*) are beginning to be exported from Brazil to the United States in experimental quantities. They are considered by many to be superior to Brazil nuts.

*Cacao* or *chocolate* (*Theobromo cacao* and related species), a highly prized food of the ancient American civilizations has become an item of great commercial importance. It is a strictly tropical tree, so that there has been no chance of the spread of its cultivation to temperate regions. The commercial product has, in the past, largely come from northern South America, Brazil, and Central America, but recently there has been a tremendous development of the industry in West Africa. Lower production costs there would constitute a serious threat to the business in tropical

America, were it not for the fact that the product from America has a much better flavor. As with coffee, cacaos produced in various localities have individual flavors, and are in demand for blending. By far the greatest portion of the American crop is produced in the state of Bahia, Brazil. (WRIGHT, H., *Theobroma cacao*, or Cocoa, its Botany, Cultivation, Chemistry and Diseases, 1-249, London, 1907. — HALL, J. J. VAN, Cocoa, ed. 2, 1-514, London, 1932. — KNAPP, A. W., The Cocoa and Chocolate Industry; the Tree, the Bean, the Beverage, 1-147, London, 1923. —FINCKE, H., Handbuch der Kakaoerzeugnisse; etc., 1-568, Berlin, 1936. — KEITHAN, E., Econ. Geogr. 15: 195-204, 1939; 16: 79-86, 1940).

The *avocado* (*Persea americana*) is a native of northern South America, where it has long been a popular food. There are many cultivated forms, of which three principal groups are grown, the West Indian, with smooth, leathery skin; the Mexican, with rough, thin skin, and anise-scented leaves; and the Guatemalan, with a thick, hard, shell-like skin. Although a fruit, its lack of sweetness or acidity and its high fat content cause it to be used rather as a salad vegetable. It is now raised in all tropical countries, and in such subtropical ones as Southern California and Florida. An intensive advertising campaign, combined with exorbitant prices, has in the past few years made it a familiar item on the tables of the more well-to-do classes in the United States. (CARVALHO BARBOSA, J., Do Abacateiro e do Abacate, Historia, Classificação, Cultura, Uzos Domesticos, Propriedades Medicinaes e Aproveimentos Industriaes, 1-342, São Paulo, 1933. — CONDIT, I. J., A Bibliography on the Avocado (*Persea americana* Miller), 1-293, Riverside, Cal. 1939. — POPENOE, W., Trop. Agr. Trin. 18: 3-7, 1941; U. S. D. A. Bull. 743: 1-69, 1919. — RYERSON, K. A., *et al.*, Calif. Agr. Exp. Sta. Bull. 365: 1-638, 1923; rev. 1-78, 1928. — TRAUB, H. P., *et al.*, U. S. D. A. Cir. 1-28, 1941. *See also* the Yearbooks of the California Avocado Association, 1915 to the present).

The *pineapple* (*Ananas comosus*), whose exact native home is not known, but is probably in southern Brazil or the upper Paraná drainage in Paraguay or northern Argentina, has become, with the exception of the tomato, the best known of all tropical fruits. It was in cultivation in pre-European times over a large part of South America and in the West Indies. The Spaniards scattered it over the Pacific and into the Orient. Many cultivated forms exist with different fruit characteristics. The center of commercial production of canned fruit is now the Hawaiian Islands, where the industry is on a thoroughly scientific basis, and it is very doubtful if it will, in the near future, be developed on a basis to compete extensively with this region anywhere in tropical America. Certain quantities of the fresh fruit are now exported from the West Indies and other parts of America. It seems likely that a large demand might be developed in the United States for fresh pineapples from the West Indies if methods can be developed for shipping some of the superior varieties that are never seen in northern markets. The present widely held opinion that canned pineapples are superior to fresh is amply justified when only the acid, unpalatable fruits now available are considered. At present, United States quarantine restrictions are only applied to pineapples grown in Jamaica and Fiji. The plant is an unusual combination of the characteristics of an air plant of the tropical rain forest with those of a desert plant. The thick spiny leaves with little provision for evaporation give the aspect of a desert succulent, while the funnel-shaped rosette with its ability to catch and hold water, and the axillary roots for the absorption of this water must have had their origin in the rain forest which is the common habitat of the bromeliads. (BAKER, K. F., and COLLINS, J. L., Am. Jour. Bot. 26: 697-702, 1939. — JOHNSON, M. O., The Pineapple, 1-306, Honolulu, 1935. — PENNOCK, W., Revista Agr. Puerto Rico 33: 521-532, 1941).

The *papaya* (*Carica papaya*) is another native of tropical America which has spread throughout the Tropics of the world as a cultivated food plant. It is raised on a small scale practically every place where it is not killed by frost, but due to its perishable nature, the fruit has been only a very limited article of commerce with temperate countries. It is possible that new methods of handling and the development of thick-skinned varieties will make possible large-scale exports to northern markets. Recently an attempt has been made to popularize canned papaya juice, and the digestive ferment, papain, is being manufactured to some extent from the latex of the unripe fruit. The family to which this plant belongs is native exclusively to tropical America. (CAMPOS GONZALES, J. G., Agr. Venez. 5 (55/56): 17-28, 1940. Revista Agr. Habana 1: 573-581, 1936. — CARVALLO, A. A., Agricultura 1 (8): 48-60, 1938. — DECKER, S., Bol. Agr. São Paulo 40: 238-269, 1940. — PEASE, V. A., Papaya and Papain. A List of References, 1-9, Washington, 1933. — STOREY, W. B., etc., Hawaii Agr. Exp. Sta. Bull. 87: 1-64, 1941; Proc. Amer. Soc. Hort. Sci. 35: 80-82, 83-85, 1938).

The *guava* (*Psidium guajava*), already widespread in tropical America before the arrival of Europeans, is now one of the most widely dispersed of all pantropic weeds. The fruits are eaten fresh locally, but their chief value is in the manufacture of jellies and jams. However, this value is, in most places, completely outweighed by the negative importance of the plant as a weed, and as a reservoir for pests attacking other fruits. (DAVY, J. B., Rept. Calif. Agr. Expt. Sta. 1898-1901, pt. 1: 86-88, 1902). Another species, the strawberry guava (*Psidium littorale*), with a red-fruited and a yellow-fruited form, native to Brazil, has become familiar throughout the Tropics, as has the feijoa or pineapple guava (*Feijoa sellowiana*). Both of these are at present of minor importance as edible fruits. (FOSBERG, F. R., Proc. Biol. Soc. Wash. 54: 179-180, 1941. — MACCAUGHEY, V., Am. Bot. 24: 122-125, 1918. — POPENOE, W., Pomona Coll. Jour. Econ. Bot. 2: 217-241, 1912).

The pulp of the fruit of a number of species of palms which are primarily important for oil is used as food rather widely by the inhabitants of various parts of the Tropics. Some species have a very oily pulp, while in others it is merely fleshy. The huge terminal bud of many of these palms is eaten as a salad or cooked and used as a vegetable. This, of course, destroys the tree.

Valuable information on other tropical Amer-

ican fruits, such as the *custard apple, soursop, sweetsop,* and other species of *Annona,* the various *Sapotaceae* such as the *sapodilla,* the *sapotas, star apple,* etc., various *Myrtaceae,* and many others may be found in the book by W. POPENOE, Manual of Tropical and Subtropical Fruits, 1-474, New York, 1920, now unfortunately out of print.

*FOOD PLANTS (INTRODUCED):* In spite of the tremendous number of native food plants already available and in cultivation at the time of the Spanish Conquest, a number of plants introduced from the Old World have assumed positions of major importance in the food economy of Tropical America. Of these, only sugar cane and the banana are of great commercial importance.

*Sugar cane* (*Saccharum officinarum*) is, perhaps, the most important of all tropical crops in world commerce. It is, in many tropical countries, the backbone of commercial economy, and its culture has been the subject of more scientific research than any other branch of tropical agriculture. The plant is native to tropical Asia, and there is some dispute as to whether or not the ancestral wild form is known. The so-called wild cane (*Saccharum spontaneum*) may be simply the seedlings from the cultivated canes which are maintained in their highly developed forms by vegetative propagation. Breeding of cane varieties has been carried to tremendous lengths, and one of the difficult problems in the industry lies in the classification and identification of the innumerable clones in cultivation. The Malaysian region is the most important competitor of tropical America in the production of cane sugar. Sugar cane is in reality a swamp plant, requiring a warm, moist climate for its best development. It may be raised in drier regions, but must there be irrigated, resulting in higher production costs. Except where protected by a tariff, cheap labor is the determining factor for a successful sugar industry. This is available in the Caribbean region, and in combination with adequate scientific methods and research facilities, should enable this region to continue to compete with the tropical Far East. All of the tropical American countries have at least a domestic sugar industry, though some, such as Mexico and Honduras, import part of their supply. Cuba, where the industry is highly developed, produces more sugar than any area of like size in the world. (SURFACE, G. T., The Story of Sugar. 1-237, New York, 1910. — BARDORF, C. F., The Story of Sugar, 1-191, Easton, Pa., 1924. — FAIRRIE, G., Sugar, 1-233, Liverpool, 1925. — EARLE, F. S., Sugar Cane and its Culture, 1-355, New York, 1928. —MARTINEAU, G., and EASTWICK, F. C., Sugar, 1-163, London, 1938. — BURMEISTER, G., Agr. in the Americas 2: 63-67, 1942. —Anon., Pan Am. Un. Commod. Comm. Ser. 13: 1-14, 1941. — DEER, N., Cane Sugar: etc., 1-644, London, 1921. — MARTIN, F., La Canne à Sucre, etc. 1-205, Paris, 1935).

The *bananas* and *plantains* (*Musa*) are commonly considered as natives of the Old World, though very early introduced into tropical America. They are all giant, tree-like herbs, growing from short, thick, underground rhizomes, the visible part of the plant consisting of a trunk-like cylinder of leaf-sheaths surrounding the slender scape, crowned by a spreading palm-like crown of enormous narrowly oblong leaf-blades, the scape bearing a spike-like inflorescence at the top, which produces the bunch of bananas. The term tree, when applied to this genus, is used only in the most superficial sense. The classification of this group is in a very uncertain state, but the plants widely introduced into America are commonly assigned to three species, between which the distinctions are not too sharp. The *plantains* (*Musa paradisiaca*) are rather unpalatable when raw, but are delicious and nourishing food cooked. The many forms are of great local importance in most tropical countries, but are scarcely exported. The *dwarf,* or *Chinese banana* (*Musa nana* [formerly *M. cavendishii*] possibly only a variety of *M. sapientum*) is one of the most delicious of all bananas eaten raw, and is widely cultivated throughout the Tropics, but rarely on a large commercial scale. The common *banana* (*Musa sapientum*) is, in its multitudinous forms, an important food plant in all tropical countries, and one form of it, the *gros michel,* has become the basis of a tremendous fruit industry in the Caribbean region. Through scientific handling and efficient merchandising the companies interested in this industry have succeeded in a comparatively few years in making the banana an important item in the diet of the United States. The present popularity of bananas and pineapples is an obvious refutation of the current idea that the food habits of a people cannot be altered. (WILDEMAN, E. DE, Ann. Mus. Colon. Marseille 20: 286-362, 1912. — FAWCETT, W., The Banana, etc., ed. 2, 1-299, London, 1921. — BASSLER, H., Jour. N. Y. Bot. Gard. 27: 49-54, 1926. — Anon., Pan. Am. Un. Commod. Comm. Ser. 2: 1-42, 1939. — BOONE, R. C. P., Le Bananier; Culture-Industrie-Commerce. 1-346, Paris, 1926. — KERVÉGANT, D., Le Bananier et son Exploitation. 1-578, Paris, 1935. — CHEESMAN, E. E., Trop. Agr. W. I. 10: 4-5, 218-221, 1933; 11: 132-137, 176-181, 203-209, 1934. — CHEVALIER, A., Rev. Bot. Appl. 15: 573-580, 1935. — POPENOE, W., Trop. Agr. Trin. 18: 8-12, 33-38, 1941).

The *mango* (*Mangifera indica*) is a well known and much esteemed tropical fruit, native to southern Asia. A tremendous number of horticultural forms are known, and since the plant is readily propagated, naturally and artificially, by seed, the quality of fruit varies greatly from tree to tree. Some are as good as the finest peach, while others are not even fit to eat. When a superior tree is found, it may be propagated vegetatively, and thus many fine clons are established. These will, doubtless, eventually find a profitable market in temperate countries, if the Mediterranean fruit fly can be controlled and the quarantine bars be lifted. Perhaps quick-freezing may be an effective solution to some of the problems encountered in placing mangoes on United States markets. (BURNS, W., and PRAYAG, S. H., Bull. Dept. Agr. Bombay 103: 1-98, 1931. — AGETE, F., Rev. Agr. Com. y Trab. Cuba 8 (4): 3-13, 1927. — DECKER, S., Bol. Agr. São Paulo 38: 554-593, 1938. — WESTER, P. J., Phil. Is. Bur. Agr. Bull. 18: 1-70, 1920; 36: 1-96, 1922).

The various citrus fruits, *oranges* (*Citrus sinensis* and *C. nobilis*), *lemons* (*C. limonia*), *limes* (*C. aurantifolia*), *grapefruits* (*C. maxima* var.), etc., are generally regarded as subtropical,

because their culture has been developed to a tremendous industry in such subtropical regions as southern California, Florida, Spain, etc., but, throughout the Tropics they are among the most important fruits. Their native home is southern and eastern Asia, but, economically they have reached their greatest importance in America. (HUME, H. H., The Cultivation of Citrus Fruits, 1-561, New York, 1926. — NAVARRO DE ANDRADE, E., Manual de Citricultura, 1: 1-198, 2: 212, 1933. — PIERES, R. B., Bol. Frut. y Hort. Min. Agr. Argent. 4 (39): 1-288, 1939. — GUILLAUMIN, A., Rev. Bot. Appl. 8: 169-176, 1928. — TOLKOWSKY, S., Hesperides, etc., 1-371, London, 1938. — POWELL, H. C., The Culture of the Orange and Allied Fruits, 1-555, Pretoria, 1930).

The *breadfruit* (*Artocarpus altilis* [formerly *A. communis* or *A. incisa*]), if properly prepared, is, to my taste, one of the most delicious foods obtainable in the Tropics. It has reached its most extensive use in Polynesia, but is occasionally met with in most tropical countries. It has been of some importance in certain of the West Indies since its very early introduction by the British, but its possibilities have scarcely been touched. It will, in the not too far distant future, probably become one of the important parts of the diet in the Tropics, and then will naturally make its appearance on the market in temperate lands. Shipping difficulties may seriously retard this, however. (WILDER, G. P., B. P. Bishop Mus. Bull. 50: 1-88, 1928. — WESTER, P. J., Phil. Agr. Rev. 13: 223-229, 1920; 17: 24-39, 1924; Rev. Agr. Puerto Rico 11 (6): 31-35, 1923; Jour. Hered. 13: 129-135, 1922. — ASPINALL, A., Bull. Dept. Agr. Trin. & Tob. 19: 224-229, 1922).

The *taro*, or *dasheen* (*Colocasia esculenta*) is an Old World starchy vegetable similar to the *yautia*, capable of supporting a large number of people on a given acreage. It is rather widely cultivated in the Caribbean, and has been tried in the Southern United States, but is nowhere of great commercial importance. (BARRETT, O. W., and YOUNG, R. A., Bol. Union Panamer. 127: 1259-1271, 1929. — WILLIMOTT, S. G., Cyprus Agr. Jour. 31: 94-108, 1936).

The *coconut* (*Cocos nucifera*) is one of the world's most important plants, being, throughout the lowland Tropics, one of the mainstays of human existence. To the primitive peoples it furnishes food, water, sugar, milk, wine, liquor, oil, cordage, thatch, basket and plaiting material, fuel, charcoal, timber, and shade. The dried meat of the nuts, called *copra*, is a large item in international trade, being the source of oil for food, soap, etc. This oil is largely produced in the Old World Tropics, at present, and may soon be largely displaced by oil from other tropical American and African palms. The coconut is not known in a truly wild condition, consequently there has been much dispute as to where it originated. The best evidence seems to indicate an Old World origin, but its introduction into the New World was certainly very early. It will grow in any well drained soil below 2,500 feet altitude, and a few places in the subtropics. For maximum production, however, a hot, humid climate is desirable. (BELFORT, R., and HOYER, A. J., All about Coconuts, 1-201, London, 1914. — COPELAND, E. B., The Coconut, ed. 3, 1-233, London, 1931. — PATEL, J. S., The Coconut: a Monograph. 1-313, Madras, 1938. — SOUTH, F. W., Coco-nut Cultivation in the West Indies, 1-46, Bridgetown, 1911).

*Rice* (*Oryza sativa*) is raised extensively in Colombia, Peru, Uruguay, Brazil, and to some extent locally elsewhere, but not in sufficient quantities even to supply the domestic market; so that large amounts must be imported. This cereal is an important food in many South American countries. It is an Asiatic marsh grass which grows best in mud and standing water. Certain varieties, the "upland rices," are adapted to dry land culture and are raised in some regions in tropical America. (COPELAND, E. B., Rice, 1-352, London, 1924. — GRANATO, L., O Arroz, 1-525, São Paulo, 1914. — GUATCHIN, G. G., Riz et Rizicult. 12: 61-96, 1938).

*Wheat* (*Triticum aestivum*) also is raised locally, especially in the Central American and Colombian highlands, but in insufficient amounts in the truly tropical areas to take care of domestic consumption. *Barley* (*Hordeum vulgare*) is also grown to a slight extent in the Andes.

The *pigeon pea* (*Cajanus cajan*) is raised domestically for human consumption in Puerto Rico and other West Indies. Elsewhere in the Tropics it is of importance as a stock feed and green manure, and locally as a food. It came originally from southern Asia.

*Chick peas* (*Cicea arietinus*), from the Mediterranean region, are widely grown for local consumption, especially in dry regions. As it is an annual, it is well adapted to conditions there.

*FORAGE:* Grazing has long been one of the important branches of agriculture in most Latin American countries. Cattle and sheep are, of course, most commonly associated with the pampas or temperate grasslands of Argentina and Uruguay, where meat and hide production is developed to an enormous extent. However, the vast forage resources in the tropical grasslands of *llanos* of Venezuela, Bolivia, Brazil, and other regions are among the most valuable in the world. The deep native vegetation of many of these regions would support a large amount of stock, and indeed does, in many parts. Cattle and hogs are the important animals here. The main obstacle to full utilization of these areas is the lack of breeds of cattle which are resistant to heat, ticks and other pests, and diseases. Some attempts are being made to introduce resistant stock of Brahman (or East Indian) origin from Texas, but the expense involved makes this a slow process. The progeny of these are rapidly increasing in tropical Mexico. At higher altitudes where the climate is more temperate, as in parts of Mexico, Colombia, Peru, and Bolivia, stock-raising is a thriving business. Here, in the more fertile valley areas, cattle are pastured, while on the rocky upper slopes where the grass is sparse, sheep, and in the central Andes llamas and alpacas, are maintained. Goats are widely raised in drier regions, especially in Mexico. Wild forage plants are, throughout tropical America, the important source of stock feed, but attempts are being made in various parts to secure and introduce others which will stand up better under grazing conditions, produce more forage, or which have other good qualities. Persistent overgrazing is, here as elsewhere, one of the great-

est dangers to the permanence of the forage resources. (AGUILAR G., J. I., Ensayos en el Estudio do Plantas Forrajeras en Guatemala City, 1939. — GANDARA, G., Agricultura 2 (13): 14-21, 1939. — ABADIA, S., Rev. Nac. Agr. Soc. Agr. Col. 32: 1211-1243, 1937. — MEYER, T., Rev. Arg. Agron. 7: 95-104, 1940. — Informações sobre algumas plantas forageiras, ed. 4, 1-201, Estas. Exp. Agros. Brasil 1937. — AVILA DE ARAUJO, A., Bol. Agr. Ind. e Com. Rio Gr. do Sul 28: 1-54, 1939; 19 (2nd ed.): 1-55, 1940. — WHYTE, R. O., CHRON. BOT. 6: 443-446, 1941, with an extensive bibliography.— SHREVE, F., Madroño 6: 190-198, 1942).

*SPICES AND FLAVORS:* Plant parts containing aromatic or pungent substances which are used in food preparation are known as spices. Extracts of the aromatic principles of spices and other plants used in imparting an odor to foods are known as flavors. Their function is to make foods more palatable and to stimulate the appetite. In the period when they had their greatest development, lack of refrigeration gave them a tremendous importance in rendering semi-spoiled foods edible at all. Some of them doubtless functioned as preservatives. Though these latter functions are no longer necessary, the trade in spices is still a large and important one. Most of the commercial spices are produced in the Old World, but a few are of considerable importance, and some of the others are raised in small quantities here and there, in America. The reason why a certain few out of thousands of aromatic plants have been selected as spices for human consumption is likely a matter of historical accident. Europe is quite poor in such species, so that those discovered in use by native peoples in the Tropics were very easily taken over and became a part of the commerce and cuisine of western culture. A great many other members of such families as *Myrtaceae, Lauraceae, Rutaceae, Umbelliferae, Labiatae, Compositae,* etc., have pleasant or pungent aromatic odors and would seem suitable for use as spices and extracts. The chief obstacle is the difficulty or impossibility of changing the food habits of any considerable number of people. Shortages of standard spices due to the war might well give sufficient stimulus to effect the establishment of new spices if commercial interests have sufficient imagination to try them when the shortages become acute.

The two principle native American contributions to the spice trade are ***allspice*** (*Pimenta officinalis*) produced in the Caribbean region, principally in Jamaica, and ***Cayenne, red*** or ***chili pepper*** (*Capsicum annuum* or *C. frutescens*), many varieties of which are raised in all parts of the Tropics mostly for local consumption, though prepared red pepper is exported from Mexico. (BRAVO H., H., Anal. Inst. Biol. Mex. 5: 303-321, 1934). Of the Asiatic spices ***ginger*** (*Zingiber officinale*), ***black pepper*** (*Piper nigrum*), ***cinnamon*** (*Cinnamomum zeylanicum*), and ***cloves*** (*Eugenia caryophyllata*) are raised to a minor extent in the Caribbean and in the Guianas. This culture has never been of much importance excepting the extensive Jamaica ginger production, but present conditions may well stimulate it. (VANEGAS, F. G., Rev. Agr. Trop. (El Salv.) 12: 142-144, 1939. — Anon., *ibid.*, 185-187).

Of flavoring materials, ***vanilla*** (*Vanilla fragrans*), native to Mexico, is one of the world's most important. The plant is an orchid of which the seed capsules, called "vanilla beans," are subjected to fermentation to produce the delicious odor, then extracted with alcohol. In the New World vanilla is produced commercially in Mexico, Bolivia, and the West Indies. Substitutes, based on synthetic ***vanillin*** and on ***coumarin*** from ***tonka beans,*** are very widely used but are quite inferior to the natural extract. The culture of this plant is usually a small-scale proposition, as the plants require much individual attention, and in most localities each flower has to be pollinated by hand. (LECOMTE, H., Le Vanillier, 1-228, Paris, 1902. — DILLON, G. W., Am. Orch. Soc. Bull. 10: 339-343, 1942. — CASTRO CANCIO, J. DE, La Industria Vainillera, etc., 1-12, Mexico, 1924. — LOPEZ Y PARRA, R., La Vainilla, etc., 1-78, Mexico, 1911. — VALDIVIA, M. A., Hacienda 18: 374-376, 1923). ***Tonka beans*** (*Dipteryx odorata* and *D. oppositifolia*). from northern South America, are a principal source of *coumarin,* which is an important flavoring material in its own right but which has earned some disrepute as an adulterant or substitute for vanilla. The extract is made from the dried seeds. (DUCKE, A., Trop. Woods 61: 1-10, 1940. — POUND, F. J., Trop. Agr. Trin. 15: 4-9, 28-32, 1938). *Sarsaparilla* is made from the roots and rhizomes of certain species of *Smilax.* Several Caribbean and northern South American countries export it to the United States, but the exact identity of some of the species producing it has not been determined. A factory for the manufacture of *Citrus* oils has been established in British Guiana. *Lime* oil is produced in considerable amounts in Jamaica and Mexico. (MCNAIR, J. B., Field Mus. Pub. Bot. 6: 1-392, 1926).

(RIDLEY, H. N., Spices, 1-449, London, 1912. — GUILLARD, F., Les piments des solanées, etc., 1-123, Lons-Le-Saunier, 1901. — COCHRAN, H. L., Bull. Torr. Bot. Club 67: 710-717, 1940. — JANK, J. K., Spices: etc., ed. 4: 1-181, New York, 1924. — REDGROVE, H. S., Spices and Condiments. 1-361, London, 1933. — MACMILLAN, H. F., Trop. Agr. 33: 223-228, 1909. — RAMIREZ CANTU, D., Foll. Divulg. Cient. Inst. Biol. Mex. 32: 1-35, 1940. — LECLERC, H., Les épices, etc., 1-134, Paris, 1929).

*PERFUMES:* The production of materials used in perfumery has been developed only to a minor extent in the American Tropics, in spite of a vast number of potential sources of materials. Certain balsams (mentioned under GUMS and RESINS) are exported for use as fixatives for certain essential oils. *Oil of Bay,* produced by distillation of the leaves of the ***bay-rum tree*** (*Pimenta racemosa* [*P. acris*]), comes from wild trees in the Virgin Islands. (JONES, J., Kew Bull. (1919): 152-160, 1918. — POUCHER, W. A., Pharm. Jour. 112: 186, 1924. — FISHLOCK, W. C., W. I. Bull. 12: 196-197, 1912. — COLLINS, A. E., and WARNESFORD, R. H. S., *Bay Oil* and *Bay Rum.* 1-13, Roseau, Dominica, 1926. — SHAW, E., Econ. Geogr. 10: 143-146, 1934). It is used in making bay-rum, but in recent years the demand for this toilet preparation has considerably decreased. Paraguay produces most of the world supply of ***petitgrain oil*** from the leaves of the ***bitter orange*** (*Citrus aurantium* L.). (ALBES, Bull. Pan Amer. Un.

p. 1-3, 1923). *Linaloe oil* is distilled from the wood of several trees. *Mexican linaloe* comes from several species of *Bursera,* while *Cayenne linaloe* or *bois-de-rose oil* comes from *Aniba rosaeodora* of French Guiana, and similar oils from other species of *Aniba.* Several plants which are used in perfumery elsewhere, such as *cassie* (*Acacia farnesiana*), *lemon-grass* (*Cymbopogon citratus*), and *khuskhus,* source of *oil of vetiver* (*Vetiveria zizanioides*), are either native or widely naturalized in tropical America but are not or scarcely used. Development of plantations of *citronella* (*Cymbopogon nardus*), *lemongrass,* and *ylang-ylang* (*Cananga odorata*) are now being made in Haiti and the Dominican Republic. Probably the lack of cheap labor in most parts of Latin America prevents these and numerous other flower perfumes and aromatic wood or leaf oils from being further utilized. (Harlan, W. V., Agr. in the Americas 2: 68-71, 1942. — Maunier, E., Les Plantes à Perfums des Colonies Françaises. 1-134, Marseille, 1928. — McNair, J. B., Field Mus. Pub. Bot. 6: 1-392, 1926. — Choux, P., Mat. Grass. 15: 6450-6452, 1923. — Freise, F. W., Perf. & Ess. Oil Rec. 22: 370-371, 1931; 23: 80-82, 1932. — Garcia de Arrillaga, N., Rev. Agr. Puerto Rico 31: 496-504, 1939. — Gildemeister, E. and Hoffmann, F., The Volatile Oils, ed. 2 (transl. by E. Kremers), London, 1: 1-677, 1913; 2: 1-686, 1922; 3: 1-777, 1922. — Finnemore, H., The Essential Oils, 1-880, London, 1926. — Naves, Y. R. and Mazuyer, G., Les Parfums Naturels, etc., 1-398, Paris, 1939. — Parry, E. J., Parry's Cyclopaedia of Perfumery. 1-840, London, 1925).

*BEVERAGES, STIMULANTS AND NARCOTICS:* These classes are treated together since, with the exception of food-beverages, such as milk and fruit juices, and the unaccountably popular carbonated beverages, all important drinks contain a stimulant, either alcohol or caffeine or other caffeine-like substance. Some of these beverages are major articles of commerce on a world-wide scale.

*Coffee* (*Coffea arabica* and other species) is South America's largest export. The plant, whose roasted and ground seeds are boiled or treated with hot water to make this drink, is not an American plant, but a native of the Red Sea region which has found a congenial home in many tropical countries. Brazil dominates the coffee industry and would undoubtedly monopolize it completely were it not for the fact that coffees produced in other regions have different flavors, and are in demand for blending with the Brazilian product. Some coffee is, therefore, produced in most tropical countries. The plant demands a moist, warm climate, but if the heat is too intense it must be shaded by larger trees. (Ukers, W. H., All About Coffee, ed. 2, 1-818, New York, 1935.—Amaral, A. P. de Cultura Practica e Racional do Cafeeiro. 1-607, São Paulo, 1925. — Camargo, R. de, Cultura cafeira, etc., 1-100, São Paulo, 1929. — Martin, F., Le Caféier; principes techniques et économiques de la culture de cette plante, 1-224, Paris, 1938. — Jacob, H. E., Coffee; the epic of a commodity [transl. by E. & C. Paul], 1-296, New York. — Cheney, R. H., Coffee; a monograph of the economic species of the genus *Coffea* L., 1-244, New York, 1925. — Reid, W. A., Pan Am. Union Commod. Comm. Ser. 17: 1-39, 1936. Chevalier, A., Les Caféiers du Globe. fasc. 1: 1-196, Paris, 1929).

*Yerba maté, maté* or *Paraguay tea* (*Ilex paraguariensis*) is a native in the Paraná drainage of Brazil, Paraguay, and Argentina, where the gathering of leaves from the wild plants is an important industry. Some is produced from cultivated plants, but this is considered inferior. The ground heat-dried leaves are the basis of a tea which is the common drink in many parts of South America. They contain the same stimulating substance, *theine,* as does the Asiatic tea. Maté has never become popular in the United States or Europe, though attempts are now being made to introduce it to the people of North America. It is used as an ingredient in certain soft drinks in this country, and so is imported to some extent. (Cabral, O., Brazil 159: 14, 1942. — Hannay, A. M., U.S.D.A. Bur. Agr. Econ., Econ. Libr. List 16: 1-9, 1940. — Clos, E. C., Agronomia 30: 117-141, 1941. — Reid, W. A., Pan Am. Union, Commod. Comm. Ser. 4: 1-23, 1926. — Joyce, T. A., Nature 134: 727, 724, 760-762, 1934. — Anon., Bol. Min. Agr. Industr. e Comm. Brasil 18: 439-495, 603-664, 1929).

*Guaraná* (*Paullinia cupana*) is used by the inhabitants of Amazonia in the form of a powerfully stimulating beverage made from the seeds. Its caffeine content is several times that of coffee. Its use has not spread to any extent beyond Brazil. It is cultivated to a certain extent. The seeds are ground into a paste with cassava flour, moulded and dried in smoke, the resulting hard dry product keeping indefinitely. (Agan, J., Bull. Pan Am. Un. 51: 268-275, 1920. — Bariédo Carneiro, P. E. de, La Guarana et *Paullinia cupana* H. B. & K. 1-124, Paris, 1931. — Ducke, A., Rodrig. 3: 155-156, 1937. — Schmidt, F., O Campo 1 (7): 74-79, 1930).

Of alcoholic beverages *rum* is the primary one produced and consumed in the Tropics. It is made by fermentation of molasses or of sugar cane juice and subsequent distillation. It is made locally in most tropical countries, especially those important as sugar producers, but most of that exported comes from the West Indies, particularly Jamaica, Puerto Rico, Cuba, and the Virgin Islands. *Habanera* is a fine rum produced in Mexico. (Kayser, E., Ann. Sci. Agron. 34: 159-195, 411-454, 1917. — Newlands, J.A.R., Sugar, a Handbook for Planters and Refiners. 1-876, London, 1909. — Ball, J., A Practical Treatise on the Culture of Sugar Cane, and Distillation of Rum, etc., 1-58, Calcutta, 1831). *Aguardiento* is raw sugar-alcohol, sweetened and flavored with anise or other strong flavor, and is a popular poor man's strong drink. *Guarapo* is fermented sugarcane juice or a fermented sugar solution, very cheap and widely used among the country people. It resembles cider.

*Chicha* is a vile-smelling drink made from a decoction of corn and molasses, fermented and consumed immediately, a soup-like, milky suspension. Drunk to excess by poorer classes in Colombia, it is held responsible for much of their poverty and backwardness.

*Pulque* is the national drink of Mexico. It is the fermented sap from a number of large species of *maguey* or *century plants* (*Agave*), which is collected in a pit made in the top of

the plant when it is ready to send up a flower stalk. The clear liquid which fills this pit is known as *aguamiel*. After fermentation this becomes milky in appearance and frothy, with a sour odor. Great quantities are consumed by the poorer classes in Mexico, and the preparation, delivery and sale of it form an important industry. The plants are cultivated in large plantations. In recent years, however, the Government of Mexico has endeavored to discourage the production of this drink, it seems, with considerable success. (MICHOTTE, F., Agaves et Fourcroyas, ed. 3: 284-367, 1931. — HOUGH, W., Proc. U. S. Nat. Mus. 33: 577-592, 1908. — EGELING, B. F. G., Abh. Ber. Ver. Naturk. Kassel 40: 1-14, 1894. — CRIST, R. E., Econ. Geogr. 15: 189-194, 1939).

*Mezcal* or *mescal* is a fiery liquor distilled from a mash made from roasted stems of a number of the smaller species of *Agave* in Mexico. *Tequila* is a form of this made in the vicinity of the city of Tequila, Jalisco, from *Agave tequilana*. (EGELING, B. F. G., *l.c.*). A similar liquor called *sotol* is distilled from a mash of *sotol* (*Dasylirion*, several species). About Comitan, in Chiapas, Mexico, is distilled *comiteca*, an especially fine liquor, from a mixture of an *Agave* mash and fermented sugar cane juice. It thus partakes of the qualities of both rum and mescal, perfectly blended.

Grapes are raised for wine to some extent in Peru, Brazil, and, of course in Argentina and Chile. In Peru and Chile a powerful grape spirits called *pisco* is distilled from wine.

*Tobacco* (*Nicotiana tabacum*) is the most widely used of all mild narcotics. It is an American plant which was widely smoked by the Indians in prehistoric times. By 1610 its use had spread over the entire world. Most of the enormous tobacco crop is grown in warm temperate regions, but Brazil and the West Indies are rather important areas for its production. Colombia has an important domestic tobacco industry. (CAPUS, G., LEULLIOT, F., and FOX, E., Le Tabac, 1-843, 1929. — ARENTZ, G., Tobacco, Its History, etc., 1: 1-543, 1937; 2: 1-564, 1938, 3: 1-545, 1941. — GARNER, W. W., Bibliografía Selecta sobre el Tabaco, 1-25, 1933. — LEULLIOT, F., Bull. Soc. Nat. Accl. France 86: 73-87, 1939).

*Coca*, widely used as a stimulant in South America, is mentioned under medicinal plants.

*PHARMACEUTICAL PLANTS*: Since prehistoric times the lore of medicinal plants has been one of the most important phases of economic botany. Indeed, the science of botany began as one of the main parts of the science of medicine. With the advance of medical knowledge, more and more of the herb remedies used in the past have been found to be useless or much inferior to modern treatment and remedies of other sort. Synthetic chemicals have replaced many of the drugs previously obtained from plants, until, with a few important exceptions, plant remedies have been largely dropped from standard medical practice. This has not led to as much decrease in the production of these drugs as might be expected, though some of them have largely disappeared. Local and home doctoring still rests much faith in the old remedies, and the patent medicine trade, much of it based on vegetable drugs, does an enormous business. In tropical America a large number of aboriginal remedies are still in everyday use and there is a thriving local commerce in the herbs and other plant products which are the important ingredients. Few of these enter the drug trade and very little is known as to the plant species from which they are derived. There is always a possibility that some of them may really contain valuable substances. (HIGBEE, E. C., Agr. in Amer. 2: 91-93, 1942).

Of the several tropical American drugs which still have a wide importance, *quinine* and *cocaine* stand preeminent. Both were in use by the Peruvian Indians long before the Spanish Conquest. *Quinine*, obtained from the bark of several species of *Cinchona*, is still the main specific for malaria, and has many other uses in the drug trade. Formerly obtained from wild trees on the eastern slope of the Andes, as far south as Bolivia, various unsuccessful attempts have been made to produce the drug commercially in plantations in the New World. In recent years almost the entire trade has been taken over by the Dutch planters in the East Indies. Now that the Malaysian source has been lost, renewed and highly successful efforts are being made to develop sources in America. Much is available from wild trees which have had a chance to recover from the effects of exploitation, and some from the small, more or less experimental plantations which have been established in the past and usually abandoned. The classification of *Cinchona* is in a state of extreme confusion due to the large number of species described, mostly based on trifling differences. There are probably not more than five or six actual species in the genus, but these have a great amount of local variation. Some of the variants have a much higher quinine content than others. The Dutch planters had selected greatly superior strains, based on the so-called *C. ledgeriana*, a form of *C. officinalis*, or of *C. calisaya*, if the Bolivian plants represent a distinct species.

A new method of utilization, the production of *tota-quina*, a mixture of all the alkaloids of the bark, rather than the pure refined *quinine*, gives some promise of success in America. Lower-yielding trees, such as the *succirubra* forms, are suitable for *tota-quina*, and it is possible that the use of young trees and seedlings may be successful. The resulting product, though by no means as effective as purified quinine sulfate, is much cheaper, as the expensive refining processes are dispensed with. Thus the remedy is placed within reach of great numbers of people who could not afford quinine, though needing it badly. (MARAÑON, J., and BARTLETT, H. H., Nat. Appl. Sci. Bull. 8: 111-188, 1941. — Anon., Panam. Un. Commod. Comm. Ser. 24: 1-14, 1942. — Sci. Lib. Bibl. Ser. Sci. Mus. (South Kens.) 483: 1-5, 1939. — FOSBERG, F.R., Colombian Cinchona Manual, 1-27, Bogotá, 1943. — GROOTHOFF, A., De Kinacultuur, 1-109, Haarlem, 1912. — HOEHNE, F. C., Caracteres Botanicos, Historia e Cultura das Cinchonas. 1-39, São Paulo, 1919. — PERROT, E., Quinquina et Quinine. 1-174, Paris, 1926. — STOCKDALE, F., East Afr. Agr. Jour. 5: 283-286, 1940. — KERBOSCH, M. G. J., Geneesk. Tijdschr. Nederl. Ind. 71: 317-344, 1931. — POPENOE, W., Trop. Agr. Trin. 18: 70-74, 1941. — PRETEL VIDAL, A. R., Bol. Agr. Ganad. Peru 8: 11-103, 1938; 9: 3-80, 1939. — SCHULTZ, E. F., Rev. Ind. y Agr. Tucumán 30: 197-199, 1940).

*Cocaine* obtained from the leaves of the *coca* plant (*Erythroxylon coca*), is still widely used as a local anaesthetic, as well as being the basis of a widespread form of drug addiction. The plant, a native of the eastern Andean slopes of Peru and Bolivia, was known in prehistoric times to the Indians, who chewed the leaves with lime or ashes to get a prolonged stimulation which enabled them to work or travel incredible periods without rest or food. The plant is now cultivated extensively from Peru to Argentina on the east slope of the Andes, as well as in the Orient, and the dried leaves are exported to some extent. However, the amount exported is small compared with that of the leaves chewed in South America, where the habit is very widespread. Export is subject to strict international regulation, as addiction to the drug is all too common. (REID, W. A., Pan Am. Un. Commod. Com. Ser. 20: 1-20, 1936. — BUES, C., Bol. Agr. y Ganad. Peru 5: 3-72, 1935. — DOMINGUEZ, J. A., Trab. Inst. Bot. y Farm. Buenos Aires 47: 1-16, 1930.)

*Ipecac,* an emetic produced from the roots of *Cephaelis ipecacuanha,* is still a standard pharmaceutical item, and is produced in the lowlands of Brazil. (BAL, S. N., Ind. Jour. Pharm. 2: 9-19, 1940. — COSTA, O. DE A., and PECKOLT, O. DE L., Rev. Fl. Med. Bras. 2: 197-234, 261-297, 333-350, 1936). *Jalap,* a powerful physic, is produced in Mexico from the root of *Ipomoea purga.*

*Wormseed* (*Chenopodium ambrosioides* var. *anthelminticum*) is cultivated in various parts of America as a local remedy for many ailments. An oil derived from the plant is widely used as a vermifuge.

*Cubebs* (*Piper cubeba*), *balsam of Peru* (mentioned under GUMS and RESINS), *guaiacum* (mentioned as *lignum vitae* under TIMBERS), and *quassia* (*Quassia amara* and *Picraena excelsa*) are other drugs from tropical America which are still articles of commerce. *Thevetin* is a new drug, obtained from the seeds of the common American ornamental tree, *Thevetia peruviana,* which is expected to replace *Digitalis,* at least in part, in treating heart ailments.

The various forms of *curaré,* the deadly arrow poison of the Indians of Amazonia and northern South America, yield valuable drugs. A number of plants enter into their composition, different in different regions. Active investigation is being carried on to learn more about the constituents and botanical origin of this class of poisons. (KRUKOFF, B. A., and MOLDENKE, H. N., Brittonia 3: 1-74, 1938. — LIMONGI, J. P., Ann. Fac. Med. Univ. S. Paulo 14: 297-331, 1938. — VELLARD, J., Compte Rend. Acad. Sci. Paris 208: 2104-2106, 1939. — FOLKERS, K., Arch. Int. Pharm. Thér. 61: 370-379, 1939; Jour. Am. Pharm. Assoc. 27: 689-693, 1938).

Two other plants should be mentioned here that are used by the Amazonian Indians for their narcotic effect. *Maikoa* (*Brugmansia arborea*) and *yagé* or *caapi* (*Banisteriopsis caapi*) both produce hallucinations and other mental disorders. (CARDENAS, M., Bolivia 8 (7): 13, 25-26, 1941. — COSTA, O. DE A., Rev. Fl. Med. Bras. 2: 575-624, 1936. — DOMINGUEZ, J. A., Trab. Inst. Bot. y Farm. Buenos Aires 48: 1-15, 1931. — GAGNEPAIN, F., Rev. Bot. Appl. 10: 292-294, 1930. — REKO, V. A., Heil- und Gewurz-Pfl. 15: 135-141, 1933. — REINBURG, P., Jour. Soc. Amer. Paris, n. s. 13: 25-54, 197-216, 1921. — MORTON, C. V., Jour. Wash. Acad. 21: 485-488, 1931).

Small quantities of various other drug plants, both indigenous and introduced, are grown or gathered locally in various countries, for example, Cuba. (For other drug plants see also under BEVERAGES and STIMULANTS).

(BATAN, P. P., Dictionnaire des Plantes Médicinales, etc., 1-275, Paris 1935. — FONSECA, E. T. DA, O Campo 11, 20, 26, 28, 1940. — Rev. Fl. Med. Bras. 1: 289-296, 691-696, 1935. — FREISE, F. W., Pharm. Zentralbl. 74: 577-578, 1933; Tropenpfl. 37: 469-486, 1934; 39: 241-253, 380-389, 513, 524, 1936; 41: 60, 1938: Perfum. & Ess. Oil Rec. 22: 370-371, 1931. — SANTA CRUZ, A., Rev. Chil. Hist. Nat. 33: 279-281, 1930; 37: 145-147, 1933; 39: 34-41, 1935. — COSTA, O. DE A., Rev. Fl. Med. Bras. 1: 415-422, 1935. — DIAS DA SILVA, R., Rev. Fl. Med. Bras. 1: 477-487, 1935; 4: 59-76, 1937. — MARTINEZ, M., Cron. Med. Mex. 23: 227-230, 1924. — BACHSTEZ, M., Jour. Am. Pharm. Assoc. 30: 218-219, 1941).

*INSECTICIDES:* Most of the important recently developed insecticides of plant origin depend upon the chemical *rotenone,* as their active principle. This substance is present in greater or lesser quantities in a considerable number of plants, many of which are known to aboriginal peoples in different parts of the world who use them as fish poisons. Their usefulness is enhanced by the fact that rotenone, though poisonous to cold-blooded animals and insects, is harmless to humans and other warm-blooded animals. Three of the principal rotenone-producing genera are *Derris, Lonchocarpus,* and *Tephrosia,* all tropical members of the *Leguminosae.* The principal commercial source of rotenone in South America is *cubé* or *timbo* (*Lonchocarpus nicou, L. urucu* and perhaps other species) which are possibly not known truly wild, but are widely cultivated by the Indians as fish poisons, and persist in the forest after cultivation. The plants do not produce flowers or fruits under ordinary conditions, and are propagated by cuttings. In the roots the rotenone is highly concentrated. These roots are largely produced on plantations in Peru and Brazil. Many other plants are used as fish poisons in various parts of tropical America, but none of them have become commercially important as insecticides. (GRESHOFF, M., Meded. 'sLands Plant. Batavia, no. 10, 1893; no. 29, 1900; Meded, uitg. Dept. Landb. Batavia, no. 17, 1913. — KILLIP, E. P., and SMITH, A. C., Jour. Wash. Acad. 20: 74-81, 1930; Rept. Smiths. Inst. 1930: 401-408, 1931; Some American Plants Used as Fish Poisons, mimeogr. 1-27, Washington, 1935. — FERNANDES DA SILVA, R., Bol. Agr. Zool. e Vet. Minas-Ger. 7: 213-223, 1934. — LEGROS, J., Int. Rev. Agr. 30: 11T-29T, 51T-61T, 1939. — ROARK, R. C., *Lonchocarpus* (Barbasco, Cube, and Timbo). A Review of Recent Literature, 1-174, Washington, 1938. — WILLE, J. E., Bol. Estac. Exp. Agr. La Molina 11: 1-117, 1937. — WILLIAMS, L., Bol. Soc. Venez. Cienc. Nat. 6: 21-33, 1939. — ROARK, R. C., *Tephrosia* as an Insecticide, A Review of the Literature, 1-165, Washington, 1937. — ALBIÑANA MARCET, R., Rev. Assoc. Cafet. Salv. 6: 341-360, 387-413, 1936. — HOLMAN, H. J., A Survey of Insecticide

Materials of Vegetable Origin, 1-155, London, 1940).

*Pyrethrum* (*Chrysanthemum cinerariaefolium*) is being raised experimentally in several South American countries. In Brazil, *pyrethrum flowers* are being produced in exportable quantities. It has long been used as the active principle of many insect powders and sprays. (GNADINGER, C. B., Pyrethrum Flowers, ed. 2, p. 1-380, 1936.—ALCIDES O., J., Min. de Fomento, Peru, Cir. 67: 1-31, 1940).

*OIL PLANTS:* One of the major classes of economically important plant products is that of vegetable oils and waxes. As foods, lubricants, and as raw materials in paint- and soap-making and various other industrial processes these products are consumed on an enormous scale at present, and the demand for them is bound to increase rather than decrease as civilization becomes more complex. The number of plants that produce usable oils is enormous, including a large number that are abundant in tropical America. However, the number that may become of commercial importance is determined by the quantity of oil that each produces, the expense involved in its cultivation, and the ease of extraction. Many are trees, which adds the factor of waiting for production, also the irregular fruiting which characterizes some tropical species. Furthermore, the properties of the individual oils vary, and some are more valuable than others. Certain of the oils deteriorate rapidly between harvesting and processing. Only a few of the more important oil-producing species can be mentioned here. (JAMIESON, G. S., Vegetable Fats and Oils, 1-444, New York, 1932.—JUMELLE, H., Les Huiles Végétales, 1-496, Paris, 1921.—WILSON, O., Pan-Am. Un. Commod. Comm. Ser. 5: 1-29, 1928.—Anon., *ibid.* 5: 1-30, 1938.—MORAES CARVALHO, J. B. DE, Notas sobre a Industria de Oleos Vegetaes no Brasil, 1-226, Rio de Janeiro, 1924.—ARAUJOS GOÉS, P., Bol. Min. Agr. Ind. e Comm. Bras. 7 (3): 25-38, 1919.—FONSECA, E. T. DA, Oleos Vegetaes Brasileiros, 1-130, Rio Janeiro, 1922.—LE COINTE, P., Rev. Comm. Pará 10: 199-203, 238-239, 322-333, 353-355, 376-378, 1920.—MICHOTTE, F., Mat. Grass. 15: 6354-6358, 6415-6418, 6509-6510, 6528-6530, 6547-6550, 1923; 16: 6709-6712, 1924; 17: 7034-7035, 7062-7063, 7308-7311, 7335-7337, 7363-7365, 1925).

Of the plants producing non-drying oils, besides the *peanut,* discussed above, a number of palms are the most important in tropical America. The coconut has already been discussed. The *African oil-palm* (*Elaeis guineensis*) has very rapidly assumed a place as one of the most important of all oil producers. It yields large quantities of both a pulp-oil and a kernel-oil. At present the plant is only economically important in Brazil and only slightly so there, but it seems to have a promising future. There is some dispute as to whether this species is native to West Africa, or whether it was a very early introduction there from America, where it is occasionally found wild, either native or naturalized. It is a basic food plant and an import source of commercial oil in Africa and is largely cultivated also in Malaysia. (COOK, O. F., Nat. Hort. Mag. 20: 10-35, 1940.—FICKENDEY, E., & BLOMMENDAL, H. N., Ölpalme, 1-211, Hamburg, 1929.—CHEVALIER, A., Rev. Bot. Appl. 14: 187-196, 1934.—GHESQUIÈRE, J., Rev. Bot. Appl. 14: 340-343, 1934.—HUBERT, P., Le Palmier à Huile, 1-314, Paris, 1911.—ROSS, J. H. H., Tropenpfl. 32: 99-103, 1929).

The *tucum* or *cumare* (*Astracaryum tucuma* and *A. vulgare*), of northern South America and Brazil, the *muru-muru* (*Astracaryum muru-muru*) of Brazil, the *ouricury* or *licuri* (*Syagrus coronatus*) of Brazil, and the *"Cocos pulposa"* (*Butia capitata* var. *pulposa*) of Uruguay and southern Brazil, are palms whose importance in the production of oil is well established, though the commerce in their seeds is as yet limited. Their shells are thin enough to be cracked fairly easily, and with present demands for oil, their exploitation and future development is to be considered a certainty. (SILVA, M., Cêra e Oleo de Licuri, 1-22, Rio de Janeiro, 1940.—JAMIESON, G. S. & ROSE, W. G., Oil and Soap 17: 144, 1940.—MCKINNEY, R. S. & JAMIESON, G. S., Oil and Soap, 15: 172-174, 1938).

The *babassú palms* (*Orbignya martiana* and *O. oleifera*) produce great quantities of nuts which are rich in oil. These are natives of Brazil, and exist in large stands wild. *Babassú oil* is one of the best oils for soap-making, as the resulting soap lathers freely. If it were not for the extreme thickness of the hard shell and consequent difficulty in extracting the oil, these species would doubtless have taken, long since, a large part of the market from other vegetable oils. Improved methods of extraction may possibly soon make these export crops of great importance. (FROES ABREU, S., O Coco Babacú Rio de Janeiro, 1940.—ORLOSKI, J. A., Brazil 159: 11, 1942.—STEVENSON, N. S., Trop. Woods 30: 3-5, 1932.—ELLIOTT, L. E., Pan Amer. Mag. 26: 297-304, 1918.). The *cohune* (*Orbignya cohune*) is a similar palm from Central America. It is of little importance because of the expense of collecting and cracking the nuts.

*Sesame seed oil* (*Sesamum indicum*), from an Old World plant, is produced on an important scale in Mexico. It is a valuable edible oil.

*Castor oil,* produced by the *castor bean* (*Ricinus communis*), which is not a bean but a spurge relative, is produced for export in Brazil and Paraguay, but the plant being a pantropic weed and very quickly grown, the supply will very easily keep up with the demand. Improved varieties with very large seeds, some with small seeds and high oil yield, and others of small stature to facilitate harvesting, are available. The oil, besides being used medicinally, is of some importance as a lubricant, and of much greater use in various industries, such as paint and varnish manufacture. For most uses it is altered chemically, so that it is then a different substance from the familiar medicinal oil. After some such treatments the products are to be included with the drying oils. (EBERHARDT, P., Le Ricin, ed. 3, 1-135, Paris, 1931).

*Cashew kernel oil* (*Anacardium occidentale*) (see also under NATIVE FOOD PLANTS) is a desirable edible oil, while the acrid resinous oil from cashew shells is useful in the paint and varnish industries.

Drying oils, of which there is a much more limited supply than of non-drying oils, are not produced to a great extent in tropical America.

*Sunflower oil* (*Helianthus annuus*), native to western United States (Anon., Bull. Imp. Inst. 14: 88-101, 1916), and *oiticica oil* (*Licania rigida*), native to Brazil, are produced to some extent, the former mostly in Argentina, the latter in Brazil. (BELSUNCE, G., Bull. Mat. Grass. 23: 197-202, 1939. — FERNANDES E SILVA, R., Notas Sobra a Cultura da Oiticica, 1-12, Rio de Janeiro, 1940. — HOLLAND, J. H., Kew Bull. (1932): 406-411, 1932). Experimental plantations of *tung* (*Aleurites fordii*) and *mu* (*A. montana*), sources of tung oil and chinawood oil, are being established here and there in tropical America under the stimulus of the war in the Orient, which has reduced the normal supply of these oils from China and Indochina. There are large areas in Argentina, Brazil, and Southeastern United States suitable for the culture of these trees, especially the *tung*, and some plantations are already in production. There is a good possibility that these oils may become important products for export from the warmer parts of this hemisphere, since they have assumed a major position as raw materials in the paint and varnish industry. (LEGROS, J., Revue Int. d'Agric. 28 (3, 4, 5), 60 p., 1935. — NEWELL, N., MOWRY, H., and BARNETTE, R. M., Fla. Agr. Exp. Sta. Bull. 221: 1-63, 1931. — PERROT, E., and KHOUVINE, Y., Les Aleurites producteurs d'Huiles siccatives dites Huiles de Bois, 1-50, Paris, 1926).

*VEGETABLE WAXES*, produced by many plants are yielded in commercial quantities in tropical America by two palms, the *carnauba palm* (*Copernicia cerifera*) of Brazil, which produces wax on the surface of the leaves, used in making phonograph records, and the *ouricury* mentioned above as an oil source. *Ceroxylon andicola* of the northern Andes, which produces wax on the trunk, has as yet no commercial importance.

*Candelilla wax*, produced on the stems of two Mexican shrubs, *Euphorbia antisyphilitica* and *Pedilanthus pavonis*, is imported in some quantities into the United States. *Myrica pubescens* wax is used locally for candles in Colombia. Several other plants such as *Myrica jalapensis* and *M. policarpa* are possible sources of wax, as is also sugarcane. (ALVARADO, A., Rev. Cienc. 2: 259-267, 1939. — BALCH, R. T., Sugar Jour. 4 (6): 24-29, 1914. — HOWES, F. N., Kew Bull. (1936): 503-526, 1936; (1940): 155-158, 1940. — OLSSON-SEFFER, P. H., Trop. Life 6: 36-37, 1910. — BOMHARD, M. L., Ann. Rept. Smiths. Inst. (1936): 303-324, 1937. — WHITE, R. B., Kew Bull. (1899): 203-204, 1899. — PIRES DE LIMA REBELLO, J., A Carnahubeira e sua Cêra, 1-31, Paranahyba, 1912. — WALMSLEY, W. N., Jr., Bull. Pan Amer. Un. 73: 31-42, 1939. — STRAIN, W., Jour. Geogr. 41: 121-129, 1942).

*TAGUA or VEGETABLE IVORY* is the hard endosperm of the *ivory nut*, the fruit of the *tagua palm* (*Phytelephas macrocarpa*) which grows wild in northern South Ameria, particularly Ecuador. It is exported in large quantities to the United States, as it formerly was to Europe, for the manufacture of buttons and other articles. It is a good substitute for true ivory for small articles. (REID, W. A., Pan Am. Un. Commod. Comm. Ser. 21: 1-15, 1936. — CLAES, F., Agr. Colon. 13: 291-294, 1925. — Anon., Mo. Bot. Gard. Bull. 11: 137-139, 1923. — COOK, O. F., Contr. U. S. Nat. Herb. 13: 133-141, 1910; Jour. Wash. Acad. Sci. 3: 138-143, 1913; 17: 218-230, 1927).

*CORK* is a substance produced naturally in the bark of trees. Only a few trees yield it in sufficient quantities or pure enough form to be used commercially. Chief among these is the *cork oak* of the Mediterranean. Since the supply of this has been cut off, interest has grown in the Brazilian *pau campo*, or *corticeira do campo* (*Kielmeyera coriacea*) whose bark is used domestically in Brazil when ground cork is required.

*FIBER PLANTS:* Fibers, the cell-walls of elongate, thick-walled cells, are among the most important of plant materials; indeed, they are among the basic raw materials of all cultures, civilized and primitive. They form the basis of a class of commercial commodities which ranks near the two greatest, foods and metals. Tropical America is potentially one of the world's important fiber-producing regions. Its fiber plants probably number in the hundreds, of which the following are only a few of the most important. Many plants are the bases of native industries as yet only of local significance. (BULL, S. L., Foreign Commerce Weekly 6 (6): 6-7, 1942. — OAKLEY, F. I., Long Vegetable Fibres, 1-176, London, 1928. — DEWEY, L. H., Bibliografía selecta sobre plantas fibrosas, 1-10, Washington, 1933; Fibras Vegetales etc., 1-101, Washington, 1941. — GIROLA, C. D., Pub. Mus. Agr. Soc. Rur. Argent. 51: 1-73, 1928. — AGAN, J. Bull. Pan Am. Union 50: 394-404, 1920.— TOBLER, F., Faserforsch. 3: 265-776, 1923; 12: 231-232, 1937. — HUERTA, L., An. Esc. Nac. Cienc. Biol. 1: 139-144, 1938. — Anon., Rev. Chim. Ind. 10 (105): 10-13, 1941. — KIRKWOOD, J. E., Plant World 12: 25-34, 1909).

*Surface Fibers:* The long hairs on the surface of certain seeds make up this type. They are composed of cellulose, and, depending on their tensile strength, they are used for cordage and textiles or as stuffing or filling, or for insulation. The most important are, of course, the cottons. Two of these, *upland cotton* (*Gossypium hirsutum*) and *Sea Island cotton* (*G. barbadense*) are of great commercial importance in Latin America. Cotton is produced in exportable quantities in Brazil, Argentina, Peru, Ecuador, Mexico, Nicaragua, and Haiti. Unfortunately, cotton is one of the items of which a surplus is produced in the world, so that there is difficulty in finding a market for the crop. Various cottons, including the ancestors of *Sea Island*, are natives of the New World and have been in use since prehistoric times. (SENAY, P., Le Coton, sa Production et sa Distribution dans la Monde 1: 1-220, 1937; 2: 1-261, 1939; Le Havre, 1937. — BROWN, H. B., Cotton, etc., ed. 2: 1-592, New York, 1938. — BOONE, R. C. P., Le Cotonnier, 3 vol. 1-995, 1932. — WATT, G., The Wild and Cultivated Cotton Plants of the World, etc., 1-406, 1907). Kapok (*Ceiba pentandra*) is widely grown for use as insulating or padding material. Other species of *Ceiba* and related genera native to tropical America produce a similar fiber on the seeds, and would likely prove useful if a larger demand should develop for this type of fiber, or if any of them should be found to possess special useful properties different from kapok. Just at present, due to conditions in the Orient, the outlook for fibers of the kapok type in tropical America is very bright. Ecuador is now the chief American

exporter of such fibers. (CHEVALIER, A., Rev. Bot. Appl. 4: 838-840, 1924. — BANDA, C. F., Rev. Cam. Agr. Seg. Zona Ecuador 1 (12): 28-31, 1938. — DEWEY, L. H., Hacienda 23: 26-27, 1928. — GRUNOW, W., Der Kapok in der Weltwirtschaft, 1-129, Berlin, 1928. — WARDLAW, C. W., Kapok, 1-40, Batavia, 1933. — MICHOTTE, F., Les Kapotiers et Succédanés, 1-82, Paris, 1927. — NAUBERT, H., Faserforsch. 10: 227-261, 1933. — ZAND, T. J., Kapok, etc., 1-119, New York, 1941).

*Stem fibers, commonly called soft or bast fibers,* have not been produced to any great extent in Latin America. *Flax* (*Linum usitatissimum*) is grown for fiber in Peru. (GAZZANI CISNEROS, L. F., Cartilla No. 37 Min. de Fom. Fir. Agr. y Ganad. Peru 1-20, 1940. — Anon., Deutsche Lein.-Ind. p. 48, Feb. 27, 1941). *Jute* (*Corchorus capsularis* and *C. olitorius*) is raised on slightly more than an experimental scale. (EVANS, I. B., So. Afr. Jour. Ind. 1: 198-208, 1917. — Anon., Per. Agr. Gan. y Med. Vet. 10 (12): 59-66, 1935. — FINLOW, R. S., Trop. Agr. Trin. 5: 104-106, 1928. — Anon., Kew Bull. (1891): 204-206, 1921. — CHANDBURY, N. C., Jute and Substitutes, ed. 3, 1-249, Calcutta, 1933) and *aramina* or *guaxima* (*Urena lobata*) (AMARGÓS, J. L., Agronomia II, 1: 213-219, 1941. — POUND, F. J., Proc. Agr. Soc. Trin. 40: 303-321, 1940. — CHEVALIER, A., Rev. Bot. Appl. 4: 216-219, 1924) and *Cuba jute* (*Sida rhombifolia*) (BAUDON, A., Rev. Bot. Appl. 2: 167-169, 1922) are produced on a small scale for sacking. *Roselle* (*Hibiscus sabdariffa*) produces a usable fiber, but is more important in tropical America for the edible jelly made from the buds. *Hemp* or *cañamo* (*Cannabis sativa*) is produced to some extent in Chile, Argentina, and Uruguay. (OPAZO, R., La Chacra 3 (36): 30-32, 41, 45, 1933). *Ambari hemp*, or *Papoula de São Francisco* (*Hibiscus cannabinus*) furnishes a domestic fiber in Brazil. (BARKER, S., Jour. Text. Inst. 30: P275-P304, 1939. — MONTEIRO FILHO, H. DA C., Bol. Min. Agr. Bras. 23: 61-64, 1934. — MICHOTTE, F., Les *Hibiscus* (Katmie) Culture et Exploitation, 1-100, Paris, 1928).

*Leaf* or *hard fibers* are obtained from the large, usually succulent leaves of certain monocotyledonous plants. Those of importance in America are mostly produced by large succulent arid-land plants. They are used for rope, cordage, and the coarsest fabrics. *Sisal* (*Agave sisalana*) is raised commercially in Haiti and was to some extent formerly in the Bahamas. Recent production has been largely in East Africa and Java. *Henequen* (*Agave fourcroydes*) is an important export product from Mexico, and to some extent from Cuba, while *ixtle* (several other species of *Agave* and *Yucca*), similar to *sisal*, is produced in Mexico. (DOOP, J. E. A. DEN, Cord Age Mag. 34 (2): 28, 30, 1940. — TOBLER, F., Sisal und andere Agavefasern, 1-104, Berlin-Charlottenburg, 1931. — NODON, A., Rev. Bot. Appl. 10: 376-380, 1930. — SMITH, H. H., Sisal, etc., 1-384, London, 1929. — ESCALENTE, R. B., Agr. Venez. 5 (50): 11-18, 1940. — MICHOTTE, F., Agaves et Fourcroyas, ed. 3, 1-407, Paris, 1931. — WAGENAAR HUMMELINCK, P., Rec. Trav. Bot. Néerl. 33: 223-249, 1936). Several species of *Fourcraea*, such as *Mauritius hemp* (*F. gigantea*), *Cuban hemp* (*F. hexapetala*), *cabuya* or *fique* (*F. andina*, *F. macrophylla*) (ESPINO, R. B., Phil. Agr. Rev. 16: 108-119, 1923. — MEJIA, E. G., Bol. Agr. Soc. Ant. Agr. Colomb. 227: 919-921, 1937. — LOPEZ, L., Cultivo de la Cabuyo o Fique, 1-29, Bogotá, 1937), and certain bromeliads, such as *pineapple* (*Ananas comosus*), *infuscata* (*Ananas erectifolius*); *caroa* (*Neoglaziovia variegata*), and *pita* (*Aechmea magdalenae*) (SCHULTES, R. E., Bot. Mus. Leafl. 9: 117-122, 1941. — TOBLER, F., Faserforsch. 3: 228-233, 1923. — HENRIQUES, J., O Caroá, 1-35, Rio de Janeiro, 1938. — CAMARGO, F. C., Revista Agr. [Piracicaba] 14: 321-338, 1939) are raised locally for their fibers. *Bowstring hemp* (several species of *Sansevieria*) is also grown here and there in tropical America, though on a small scale. (HEIM DE BALSAC, F., and ROEHRICH, O., Bull. Agence Gén. Col. France 19: 380-391, 1926. — BARRETT, O. W., Sansevieria, 1-4, Mayaguez, 1903. — MICHOTTE, F., Les Sanseviériés, Culture et Exploitation, 1-72, Paris, 1915).

Experimental plantations of *abacá* or *Manila hemp* (*Musa textilis*), closely related to the banana, are coming into production in Panama. Labor costs are the principal obstacle to large scale production. *Banana fiber*, from the cultivated banana (*Musa sapientum*), is of local importance on the plantations as a padding material, and may find wider use if a great enough shortage develops. (Abaca number, Phil. Agr. 12 (3-4), 1923. — MICHOTTE, F., Les Bananiers Textiles, Culture et Exploitation, 1-104, Paris, 1931. — HEIM DE BALSAC, F., ROEHRICH, O., and PONTILLON, C., Bull. Agence Gén. Col. France 20: 796-802, 1927. — TOBLER, F., Faserforsch. 14: 28-33, 1939).

Of *brush fibers* only a few are of much importance in our region. Brazil produces *Bahia piassava* (*Attalea funifera*) (BONDAR, G., A Exploração de Piassava no Estudo da Bahia, 1-16, Bahia, 1926. — LOZ, J., Bull. Soc. Nat. Accl. France 37: 1060-1062, 1890. — Anon., Kew Bull. (1899): 237-242, 1889), and *Para piassava* (*Leopoldinia piassaba*) (BURRET, M., Notizbl. 10: 1027-1028, 1930), the former from the bases of the leaf sheaths and the latter from the edges of the petioles of two palms. They are used as bristles for brooms and street-cleaner brushes and for very coarse and rough cordage. The *broomroot*, or *zacaton* (*Epicampes macroura*), a grass used in brushes, is produced for export in Mexico, where it is native. (HUERTA, L., and ANCONA, H., An. Esc. Nac. Cienc. Biol. 1: 1939-144, 1938. — Anon., Kew Bull. 8: 113-116, 1920). The husk-fiber of the *babassú palm* is locally used in Brazil for brushes. *Tampico fiber* or *ixtle* comes to the United States as a brush fiber from Mexico.

Other fibers are used for weaving hats and matting. The *Panama hat plant or iraca* (*Carludovica palmata*) looks like a stemless palm but is not, being a member of the *Cyclanthaceae*. It is native to tropical America and is cultivated in Colombia and Ecuador. Its young leaves furnish the strips which are woven into Panama hats. (Anon., Mo. Bot. Gard. Bull. 8: 113-116, 1920. — Anon., Geogr. Ex. Peru 307-310, Lima, 1939). The *hat palm* (*Sabal causiarum*) is similarly used to make Puerto Rican hats. (GREGORY, L. E., Carib. For. 1 (4): 13-16, 1940). Hats are made for local use in Peru from *rushes* (*Juncus* sp.). A species of *Pandanus* has been introduced into Dutch Guiana and its leaves are used in weaving matting and for thatch by Javanese laborers in that country. In Peru

matting is plaited from the leaves of *totora* or *cattail* (*Typha angustifolia*). Strips of the inner bark of *Cuba bast* (*Hibiscus elatus*) are used as a tying fiber. The inner bark of the Jamaican *lace bark tree* (*Lagetta lintearia*), when properly prepared and stretched makes a natural lace-like fabric which has some uses. (Anon., Bull. Bot. Dept. Jam. 9: 105, 1902).

The *vegetable sponge* (*Luffa,* several species) is known in many tropical countries. It is largely used in oil filters for various machines and as insulation and padding. The production has been mainly a Japanese and Indian enterprise, but now may become established in America, where the plants have long been grown locally, for sponges and for the edible young squash-like fruits. The "sponge" is the decorticated vascular skeleton of the fruit (MEYNERS D'ESTREY, H., Bull. Soc. Nat. Accl. France 37: 448-450, 1890. — REKO, V. A., Faserforsch. 13: 14-21, 1937. — YMBERT, M. DE, Nuevas Instrucciones para el Cultivo Científico de Luffa, etc., 1-32, Mexico, 1938. — HOWES, F. N., Kew Bull. (1931): 266-270, 1931).

*Wood-pulp,* for paper making, is not exported from tropical America to any extent as yet, but with depletion of northern forests, this may become of great importance. Much research remains to be done, however, before the adaptability of tropical trees of various kinds to this purpose will become well known. Experiments are being made in this direction on several species of *Eucalyptus* introduced into Brazil. Some wood-pulp is made for domestic use in Chile.

*TIMBERS:* In a naturally forested region such as a large part of tropical America, woods of various sorts are bound to be among the most important of all plant products. Local uses are, of course, the most vital, taken in the aggregate. Everywhere wood is one of the primary building materials and the most important fuel (see under FUELS). In some parts of South America, for example Argentina, the charcoal industry is a flourishing one. Wood is burned even in the railroad locomotives. Certain railroad companies, as the Paulista Company of São Paulo, have undertaken large forestry projects with the aim of assuring a supply of wood. *Eucalyptus,* introduced from Australia, is becoming important in this connection. (NAVARRO DE ANDRADE, E., O Eucalipto, 1-12, São Paulo, 1939). A considerable number of woods are exported from the American tropics. A few of these, such as the coniferous woods, *pine* (*Pinus*) from Mexico and Nicaragua, *cypress* (*Taxodium mucronatum*) from Mexico, *cypress* (*Cupressus benthamii*) from Mexico and Guatemala, and *Paraná pine* (*Araucaria angustifolia*) from southern Brazil and northern Argentina, are for general use. Most of those exported, however, are used for special purposes because of specific properties and qualities. Striking among these is *balsa* (*Ochroma pyramidale*) from the Caribbean region, which is the lightest of all commercial woods, yet has considerable tensile strength. Its uses are becoming more and more varied. *Spanish cedar* (*Cedrela odorata*) and other species has a strong persistent odor which has been thought to repel insects. This property, however, has been much exaggerated. It is used for cigar boxes and as a substitute for mahogany, which it resembles in appearance, though it is much softer and less valuable. (PEARSON, C. H., Cuba Rev. 15: 12-15, 1916). *Lignum vitae* (*Guaiacum officinale* and *G. sanctum*) from the Caribbean region is one of the heaviest, hardest, and densest of the commercial woods. It is used for pulleys, bowling balls, and many other small manufactured articles. (See also under PHARMACEUTICAL PLANTS). *Mahogany* (*Swietenia mahagoni* and *S. macrophylla*) from Mexico and the West Indies to the Amazon Basin, is the best known of all the tropical hardwoods. It is much prized for furniture and trimmings and has become a sort of symbol of luxury. Consequently there have been a great many cheaper imitations of it and substitutes for it placed on the market. Among the many other tropical hardwoods of commercial importance are *rosewood* (*Dalbergia nigra* and other species) principally from Brazil, *majagua* (*Hibiscus elatus*) from Cuba and other West Indies, *cocobolo* (*Dalbergia retusa*) from Mexico and Central America. *American ebony,* or *cocus wood* (*Brya ebenus*) from all around the Caribbean, and *greenheart* (*Ocotea rodiaei*) from the Guianas. As the timber supply in temperate regions becomes more and more depleted, tropical woods will inevitably increase in importance. More species will be used and larger quantities will be exported. Those countries which now protect their forests will certainly reap large dividends in the future for their efforts and foresight.

The principal difficulty in the way of large scale timber production is the mixed character of most tropical forests, with their multitude of different tree species. This makes it difficult to get large quantities of any one timber and increases the cost of operations.

(RECORD, S. J. and HESS, R. W., Timbers of the New World, 1-640, New Haven, 1943. — RECORD, S. J., and MELL, C. D., Timber Trees of Tropical America, 1-610, New Haven, 1924. — GILL, T., Tropical Forests of the Caribbean, 1-317, Washington, 1931. — Tropical Woods, a periodical edited by S. J. RECORD and issued by the Yale School of Forestry. — Anon., Kew Bull. (1904): 9-11, 1904. — NAVARRO DE ANDRADE, E., Les Bois Indigènes de São Paulo, 1-376, São Paulo, 1916. — HOWARD, A. L., A Manual of the Timbers of the World, rev. ed., 1-672, London, 1934).

*FUELS:* Outside of petroleum and a small amount of low-grade coal, all domestically produced fuel in tropical America comes from plants. Wood of many sorts is used very widely, even in railroad locomotives for which purposes large plantations of *Eucalyptus* and *Paraná pine* (*Araucaria angustifolia*) are maintained (see under TIMBERS). Wood is also used extensively in making charcoal, the principal cooking fuel of Latin American countries. In Brazil babassu nuts, and especially their husks and shells are used as fuel. Recently there has been some experimentation which suggests that babassu oil may have possibilities as a motor fuel. (ORLOSKI, J. A., Brazil 159: 11, 1942). Alcohol, from sugar or molasses may have possibilities for this purpose, but must overcome heavy competition from petroleum. In Brazil crude castor oil is used on a small scale as a fuel.

Perhaps the most interesting and unusual

fuel plant is *yareta* or *llareta* (*Azorella* sp.) of the high Andes of northeastern Chile. This is a resinous compact cushion-plant, "moss-like" in appearance, forming large mounds which are pried out of fissures in the rocks, broken up and used as fuel. It was burned by the Indians before the arrival of the Spaniards, and is the primary fuel in the furnaces of the sulphur mines in the region today. (Rusby, H. H., Jour. N. Y. Bot. Gard. 33: 54-57, 1932). A similar fuel is produced in Peru by the *champa* (*Distichia muscoides*), another high altitude cushion plant. It is the main domestic fuel of the inhabitants at high altitudes.

*VEGETABLE DYESTUFFS:* Since the extensive development of aniline dyes the plants producing vegetable dyes have ceased to have much importance, even in South America. (Wise, L. E., Am. For. and For. Life 30: 235-238, 1924). Small quantities are still used where certain permanent or non-poisonous colors are needed, or for special purposes such as biological staining. *Logwood* (*Haematoxylon campechianum*) is still exported in considerable quantities from the Caribbean region. An extract from this wood yields either a purplish-red or an intense and lasting black dye. It is also used in inks and especially in the biological stain, haematoxylin. *Fustic* (*Chlorophora tinctoria*), the heartwood of which yields yellow, brown, and olive dyes, is obtained in the tropical forests of tropical America, and is still of some importance. (Mell, C. D., Sci. Amer. Suppl. 84: 366-389, 1917). The name Brazil originated in *brazilwood* (*Caesalpinia brasiliensis*) which was found there by early explorers. It is the source of a red dye. (Holland, J. H., Kew Bull. 1916: 209-225; 1920: 79-90). *Indigo* (several species of *Indigofera*) is no longer produced commercially in the New World, though its culture could be revived very easily if the price were sufficient. The plants which, upon steeping in water, produce this deep blue dye are weedy legumes now found in most tropical countries, and could be very easily grown. A certain amount of this dye is still used where permanency is important. (Atkins, W. R. G., Sci. Progr. 16: 56-70, 1921. — Olsson-Seffer, R., Hacienda 12: 338-340, 1917). *Anatto* or *achote* (*Bixa orellana*) is imported in some quantities for use in coloring foods, as it is tasteless and non-poisonous. The red aril of the seeds yields the bright yellow dye. This is most familiar as the coloring matter furnished with margerine or other butter substitutes. (Bunting, B., Malay. Agr. Jour. 8: 336-338, 1925. — Hagen, V. W. von, Jour. N. Y. Bot. Gard. 41: 81-86, 1940. — Amargós, J. L., Rev. Agr. Rep. Dom. 33: 6-10, 1942).

(Karr, A. E., Textile Colorist 64: 1-6, 1942. — Claude, J., Rev. Chil. Hist. Nat. 33: 364-374, 1930. — Noriega, J. M., Las Plantas Mexicanas y Algunas Exoticas Productoras de Materias Colorantes, etc., 1-38, Mexico, 1919).

*TANNING MATERIALS:* A great many plants produce tannin, many of them in usable quantities. The principal ones of importance in tropical America are as follows: *Mangrove* (*Rhizophora mangle*) bark contains a high percentage of tannin. The bark is exported from Central America and great forests of the tree are present on most low tropical coasts. It is one of the principal components of the vegetation of the coastal swamps and mudflats. (Chevalier, A., Rev. Bot. Appl. 4: 340-344, 1924). *Quebracho* (*Schinopsis lorentzii*) is perhaps the most important of all sources of tannin. There are extensive forests of this species in Paraguay and northern Argentina, where large quantities of a concentrated extract of the tannin are prepared by steaming chips of the heartwood. (Ragonese, A. E., and Covas, G., Rev. Arg. Agron. 7: 176-186, 1940). Three species of *Caesalpinia* produce important quantities of tannin in their pods. They are *dividivi* (*C. coriaria*), *tara* (*C. spinosa*), and *algarobilla* (*C. brevifolia*), of which the first is exported from Colombia and Venezuela and the second from Peru. (Sprague, T. A., Kew Bull. 1931: 91-96. — Chevalier, A., Rev. Bot. Appl. 9: 298-302, 1929). *Encino* or *Encinillo* bark (*Weinmannia* various species) is the important tanning material of the higher parts of Colombia.

(Friese, F. W., Tropenpfl. 35: 70-74, 1932. — Froes Abreu, S., Contribuções para o Estudo das Materias Tannantes do Estado da Bahia, 1-30, Rio de Janeiro, 1927. — Heim de Balsac, F., Bull. Agence Gén. Col. France 22: 36-48, 119-142, 340-368, 1929. — Stockberger, W. W., Jour. Amer. Leath. Chem. Assoc. 7: 185-192, 1912; 8: 33-40, 1917. — Wilson, O., Pan Amer. Un. Commod. Comm. Ser. 6: 1-23, 1928. — Mell, C. D. & Brush, W. D., U.S.D.A. For. Serv. Cir. 202: 1-12, 1912).

*LATEX YIELDING PLANTS:* A large number of plants produce the type of milky saps collectively termed latex. In different species this substance differs tremendously in composition, and the uses and properties of the different sorts are only beginning to be known. Latex is produced by members of the *Moraceae, Euphorbiaceae, Caricaceae, Sapotaceae, Apocynaceae, Asclepiadaceae,* and *Compositae,* as well as many other families of less importance.

Of all articles derived from latex, rubber is the one used in greatest quantities. Our dependence upon supplies of latex for rubber production has been brought rudely and acutely to the attention of Americans by the current tire shortage. Tropical American rubber production is being given an impetus by the war, which should demonstrate conclusively whether or not it can compete permanently with production in tropical Asia. In the past cheap labor plus scientific agriculture have been two of the deciding factors in favor of the Malaysian region. It remains to be seen whether intensive application of American scientific effort can offset the labor factor. Present efforts toward stimulation of a small-scale native rubber industry, on an individual rather than a plantation basis, may well materially alter the whole rubber situation. (Ann. Pan Am. U. Commod. Comm. Ser. 15: 1-22, 1938. — Demmon, E. L., Jour. For. 40: 207-210, 1942. — Hemsley, W. B., Kew Bull. 1907: 153-156. — Polhamus, L. G., Agr. in Amer. 2: 29-31, 1942. — Memmler, K., The Science of Rubber, 1-770, New York, 1934).

Three principal genera furnish rubber in tropical America. *Para rubber* or *seringa* (*Hevea,* principally *H. brasiliensis*) (Ducke, A., Arg. Inst. Biol. Veg. 2: 217-346, 1935) has been, for some years past, the most important commercial rubber. The discovery, by H. N. Ridley, of an efficient tapping method (Eaton, B. J., Gard.

Bull. S.S. 9: 39-41, 1935), and the development, by the Dutch and British agriculturists, of high yielding clons and good plantation methods has enabled the planters of this species in the Malaysian region to dominate the rubber industry and to make that region the only important producing area, though the plant is a Brazilian one. (Anon., Kew Bull. 1914: 162-165. In America a leaf disease has seriously retarded plantation development of this plant. Clons resistant to this malady now promise to eliminate this difficulty. Considerable wild resources of the genus are available in Brazil and Colombia, and vast areas in the New World Tropics would be suitable for its cultivation. Small scale local cultivation by independent farmers in Latin America promises to reduce the labor advantage possessed by the East Indian planters. The U. S. Department of Agriculture, in coöperation with various Latin American governments and private interests, is now carrying on intensive work on the creation of a Western Hemisphere source of this, as well as other types of rubber. (COOK, O. F., Jour. Hered. 19: 204-215, 1928. — KLIPPERT, W. E., CHRON. BOT. 6: 199-200, 1941. — LA RUE, C. D., U. S. Dept. Agr. Bull. 1922: 1-70, 1926; Paper Mich. Acad. Sci. 9: 239-244, 1929. — MANN, C. E. T., Ann. Rep. Rubber Res. Inst. Mal. (1938): 59-114, 1939. — JERRMANN, L., Peterm. Geogr. Mitt. 50: 188-199, 1904).

*Ceara* and *Manicoba* rubbers (*Manihot*, principally *M. glaziovii*) are found naturally in the dry regions of Brazil. Their cultural requirements enable them to be produced in places unsuitable for *Hevea* and production can be started in a shorter time. They have seldom been planted in recent years, as tapping is difficult and they have not been able to compete with *Hevea*, but some wild supplies are available. (ZIMMERMANN, A., Der Manihot-Kautschuk; etc., 1-342, Jena, 1913. — Anon., Kew Bull. (1898): 1-15, 1898; (1910): 204-206, 1910. — LABROY, Jour. Agr. Trop. 8: 65-71, 1908. — LOCK, R. H., Trop. Agr. 33: 385-386, 1909. — LUDWIG, H. J., *Manihot Glaziovii*, etc., 1-21, Mexico, 1910. — UTRA, G. D', Bol. Agr. Sec. Agr. etc., São Paulo 10: 706-724, 1909).

*Central American* or *Panama rubber* or *caucho negro* (*Castilla*, principally *C. elastica*) is native in the Cordilleran and Amazonian regions and extends from southern Mexico to Peru. Low yield, poor quality of the product, and poor management, have prevented successful plantation development of this rubber source. New methods have recently been suggested which may possibly make raising of this crop more feasible. Breeding experiments, with the object of improving both yield and quality, should certainly be undertaken as, at present, the competition is between improved highly selected *Hevea* clons and unimproved *Castilla*. The latter might eventually prove to be the most useful of the two, at least in certain countries or for certain purposes. (COOK, O. F., Science 85: 406, 1937; U. S. Dept. Agr. B. P. I. Bull. 49: 1-86, 1903). In earlier times this was an important commercial wild rubber of tropical America, but destructive methods of tapping practically destroyed the supply. New trees have grown since that time to such an extent that a certain amount of wild Panama rubber is now being obtained for the war emergency. Careful harvesting could maintain this as a valuable resource in the countries where it occurs. (Anon., Kew Bull. (1899): 68-72, 159-164, 1899. — COOK, O. F., Science 18: 436-439, 1903. — HILL, A. F., Bot. Mus. Leafl. 5: 161-163, 1938).

*Guayule* (*Parthenium argenteum*), a desert shrub of northern Mexico, produces a good quality of rubber. Although its natural area of distribution extends well south of the Tropic of Cancer, it is being developed as a temperate (or subtropical) crop in the southwestern United States.

*Sapium rubber*, or *Colombian rubber* (*Sapium biglandulosum*) once was produced to some extent, and even planted, but is apparently no longer of any importance. (Anon., Kew Bull. 1890: 149-158. — JUMELLE, H., Rev. Cult. Colon. 10: 167-172, 1902. — WEBER, C. O., Reise nach einer Kautschuk-Plantage in Colombien, 1-39, Dresden, 1902).

*Balata* (from *Manilkara bidentata* and perhaps other *Sapotaceae*) is a non-elastic rubber-like substance used both as a substitute for *gutta percha* in insulation and in the manufacture of machine belting. It has also been used in place of chicle in chewing gum. Now that the supply of *gutta percha* from the East Indies is cut off the demand for *balata* will likely increase greatly. The supply all comes from wild trees, as the tree is not cultivated. (CHATELAIN, G., Agr. Colon. 24: 80-87, 111-118, 1935. — CHEVALIER, A., Rev. Bot. Appl. 12: 261-282, 347-358, 1932. — HILLIER, J. M., Kew Bull. (1911): 198-202, 1911. — DUCKE, A., Rev. Bot. Appl. 10: 849-851, 1930).

*Chicle* is the gum that forms the basis of chewing gum, and is made from the latex of the *sapodilla* (*Achras zapota*) collected from wild trees, chiefly in British Honduras and neighboring parts of Mexico and Central America. Careless tapping has rather depleted the natural supply, and some attempts have been made at cultivation of the tree for *chicle*, as it is widely grown for its fruit. Plantation *chicle* has not assumed any importance as yet. (TERCERO, J., Pan. Am. U. Commod. Comm. Ser. 14: 1-7, 1936. — KARLING, J. S., Torreya 42: 38-39, 1942; Am. Jour. Bot. 22: 580-592, 1935. — PITTIER, H. F., Jour. Wash. Acad. 9: 431-438, 1919).

*Papain*, a digestive ferment contained in the latex of the *papaya* (*Carica papaya*), has recently become important as a commercial product, being used in place of pepsin. It is extracted from the latex bled from green fruits of this widespread tropical American plant. The supply up to now has come entirely from Ceylon, but American companies are considering possible sources of supply in tropical America. (PEASE, V. A., Papaya and Papain, A List of References, 1-9, Washington, 1933).

The *cow trees* (*Brosimum utile*, *Couma guatemalensis*, etc.) furnish quantities of a latex which contains little or no resin, gum, or rubber, and which may be used as a substitute for milk. They are at present only a curiosity, but might well become very important in the future. (GRIFFITH, R. E., Am. Jour. Pharm. 7: 116-117, 1835. — Anon., Amer. Mo. Mag. & Crit. Rev. 4: 309, 1819. — JACKSON, J. R., Pharm. Jour. III, 3: 321-322, 1872. — MURRAY, J., A Descriptive Account of the Palo de Vaca, etc., ed. 2: 1-25, London, 1838).

(BRANNT, W. T., India Rubber, Gutta-Percha, and Balata, etc., 1-328, Philadelphia, 1900. — GRAFE, V., Grafes Handbuch der Organischen

Warenkunde 3 (2): 1-22, 1929. — GONGGRIJP, J. W., Bull. Dep. Landb. Suriname 43: 1-64, 1921. — HARRISON, J. B., and BANCROFT, C. K., Int. Rub. Congr. Rub. Rec., Amst. 53-58, 1914. — SCHERESAVSKI, E., Über Balata und Chicle, 1-143, Königsberg, 1906).

*GUMS and RESINS* are viscous substances produced, either normally or as a result of injuries, by many trees. They are used in varnish manufacture, perfumery, medicine, and in other ways. Most of them are imported from the Old World, or from temperate regions, but a few are produced in significant quantities in the American tropics. Perhaps the cutting off of the Old World supply will have the effect of stimulating a search for other useful ones in America. *Demerara* or *Para copal* is produced in eastern South America from the *South American locust* (*Hymenaea courbaril*), *Peru balsam* in Central America from *Myroxylon pereirae* (JUMELLE, H., Mat. Grass. 19: 7722-7724, 7750-7751, 1927. — MARTINEZ, A., Cafe de el Salvador 10: 5-72, 1940), *tolu balsam* in northern and western South America from *Myroxylon toluiferum* (VANDEN BERGHE, M., Bull. Soc. Nat. Accl. France 38: 639-640, 1891), *American styrax* in Central America from *Liquidambar styraciflua* (SPOKES, R. E., Jour. Am. Pharm. Assoc. 9: 1055-1060, 1920. — GERRY, E., Jour. For. 19: 15-24, 1921), and *copaiba balsam* in Panama, Venezuela and Brazil from several species of *Copaifera* (DUCKE, A., Rev. Bot. Appl. 12: 433-437, 1932). *Prosopis gum* or *mezquicopal*, from several *mesquites* (*Prosopis*) is produced to some extent in Mexico (BELL, W. H., and CASTETTER, E. F., Univ. N. Mex. Bull. 314: 1-55, 1937). The *cashew tree* (*Anacardium occidentale*) also produces a useful gum.

(GRAFE, V., Grafes Handbuch der Organischen Warenkunde 2 (2): 691-731, 1928. — LECOINTE, P., Apontamentos sobre as Sementes Oleaginosas, Balsamos, Resinas, etc., ed. 4, 1-60, Rio de Janeiro, 1931. — PARRY, E. J., Gums and Resins, Their Occurrence, Properties and Uses, 1-106, London, 1918).

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F. W. PENNELL: **Historical Sketch**[1]: — Before Europeans came to the shores of America at the close of the fifteenth century, the natives of the Western Hemisphere had acquired much lore concerning plants. Many peoples were already depending mainly or entirely upon plants for food. Primitive tribes would seek wild roots and fruits, but among more advanced peoples, mainly of the Mayan-Aztec and Incan cultures, crops were definitely grown. That these had been grown from far ancient times and independently of what man was achieving in the Old World is shown by the food plants of the New World being often greatly modified from their wild ancestry and by their being all different from those of the Eastern Hemisphere. The Spanish found an agriculture indigenous to the New World and highly diversified.

Agriculture, as first practiced and as still widely pursued, requires the cultivation by any people of only a few kinds of plants—one wonders if the immediate consequence of its adoption would not be to curtail man's interest in what kinds of plants surrounded him. But other uses of plants must have kept his curiosity alive. As he came to build habitations or make canoes he would use special woods, or for making clothes special fibers. But far more exacting in its requirement for precise botanical knowledge must have been the selecting of the right plants for the preparation of medicines. Early in social development it was observed that certain plants or plant-parts had curative properties, and, although innumerable false conclusions were reached empirically and magical ideas superimposed, man in both hemispheres had by 1500 A.D. accumulated an amazingly large *materia medica*. Moreover, this knowledge was not limited to the learned few, but was the necessary equipment of the people themselves. In western Europe and the United States this stage of general information about the plants of a district by the local inhabitants has been superseded by the use of manufactured medical products, but in Latin America it has survived from before the days of the Conquistadores to the present. In small villages of the Andes there is usually someone who is conversant with the wild plants, and the knowledge of centuries must enter into such a list of remedial plants as is given in SANTIAGO CORTES' "Flora de Colombia."[2]

It is with the discrimination of medicinal plants that recorded botanical knowledge of the New World commences. Had more of the Mayan works survived, we could likely point to some record of medicinal plants antecedent to the Spanish Conquest. The most we can do, and that thanks to a manuscript recently found in the Vatican library at Rome, is to show such a record within a generation of the conquest of Mexico. The liberal policy of the early viceroys of New Spain not only called for the Christianizing of the natives but for their education as well; as a result we have in 1552 the preparation of a manuscript[3] showing in color plants important as Aztec remedies, the native MARTIN DE LA CRUZ putting above each its Aztec name and his fellow convert JUAN BADIANO supplying a Latin name and a brief account. This was at the Colegio de Santa Cruz in Mexico city.

[1] In compiling this record of progress until 1850 or beyond I have drawn mainly upon the following sources: "A sketch of the history of the botanical exploration of Mexico and Central America," by W. BOTTING HEMSLEY, in GODMAN and SALVIN'S Biologia Centrali-Americana 4: 117-137, 1887; "Biblioteca Botánico-Mexicana," (especially the appended "Exploraciones botánicas en México," p. 297-368), 372 pp., Mexico, 1895, by NICOLAS LEÓN; "Notae biographicae peregrinatorum Indiae occidentalis botanicorum," by IGNATIUS URBAN, Symbolae Antillanae 3: 14-158, 1902; "Die botanischen Reisenden und Sammler in Ecuador," by LUDWIG DIELS, in Bibliotheca Botanica 116: 43-55, 1937; "Geschichte der botanischen Erforschung Perus," by AUGUST WEBERBAUER, in Die Vegetation der Erde 12: 1-29, 1911; "Vitae itineraque collectorum botanicorum," by IGNATIUS URBAN, in MARTIUS' Flora Brasiliensis 1, pt. 1, second section: 1-154, 1906; "Geschichte der botanischen Erforschung Chiles," by KARL REICHE, in Die Vegetation der Erde 8: 1-27, 1907; "Evolución de las ciencias en la república Argentina, VII. Los estudios botánicos," by CRISTOBAL M. HICKEN, in the papers commemorating the Cincuentenario de la Sociedad Científica Argentina 1-167, 1923; and for microscopic life "Mikrogeologie" by C. G. EHRENBERG in 1854.

[2] "Parte Terapeutica," comprising pages 64 to 170 of the second edition, undated, but published at Bogotá about 1919.

[3] "The Badianus Manuscript (Codex Barberini, Latin 241), Vatican Library.—An Aztec Herbal of 1552. Introduction, Translation and Annotations by EMILY WALCOTT EMMART." 341 pp., 1940. Original reproduced in color.

The earliest published work of comprehensive scope to consider the plants of the New World dealt especially with those of medical importance; this was NICOLAS MONARDES' "Historia medicinal de las cosas que se traen de nuestras Indias occidentales, que se sirven en medicina," published at Sevilla, Spain, in 1569. This dealt mainly or exclusively with products of the West Indies, Mexico, and the shores of the Caribbean Sea. The original text was in Spanish, but the work was soon translated into Latin, Italian, and French, while it was rendered with more freedom into English by JOHN FRAMPTON in 1577 as "Joyfull newes out of the new founde worlde, wherein is declared the vertues of hearbes, trees, oyles, plantes and stones." MONARDES' work must have supplied the substance of the medical information in JOSÉ ACOSTA'S "Historia natural y moral de las Indias," published at Sevilla in 1590 and even more widely translated abroad.

FRANCISCO HERNANDEZ, physician to PHILIP II of Spain, was commissioned by that monarch to prepare an account of the natural history, antiquities, and political conditions of New Spain, and he was in Mexico from 1571 to 1577. He worked diligently both there and on his report at home, but what should have been a remarkable production was allowed to lie in the library of the Escorial where with so much irrevocable matter from the early epochs of Spanish America it was destroyed in the great fire of 1671. HERNANDEZ had died in 1578. In 1615 there appeared in Mexico city a Spanish translation of a Latin manuscript of his that had been left there, Fr. FRANCISCO XIMENEZ of the convent of Santo Domingo entitling it "Quatro libros de la naturaleza y virtudes de las plantas y animales que estan recevidos en el uso de medicina en la nueva España . . . " A better known work, published at Rome in 1651, contains primarily HERNANDEZ' observations, but acknowledges the critical work of later hands: "Rerum medicarum Novae Hispaniae thesaurus, seu plantarum, animalium, mineralium mexicanorum historia ex FRANCISCI HERNANDEZ, novi orbis medici, primarii, relationibus in ipsa mexicana urbe conscriptis a NARDO ANTONIO RECCHO collecta ac in ordinem digesta: a JOANNE TERRENTIO, JOANNE FABRO et FABIO COLUMNA LYNCEIS notis et additionibus illustrata." I have before me this, with its ornate title-page containing a small map of Mexico, its woodcuts and descriptions of plants and animals, each with indigenous and Latin names, the whole a volume of over 1000 ample pages.[4a]

Not only New Spain but also Peru was yielding treasures, both in food plants and medicines. From the former came first the maize, from the latter the equally indispensable potato. From the latter, too, came quinine. It was about 1630 that the local administrator in Loja (southern Ecuador) made a satisfactory test of a bark used by the natives as a remedy for fevers, and on his suggestion the Countess DE CHINCHON, wife of the viceroy at Lima, tried it and was cured. The knowledge of the Peruvian or Jesuit's bark spread rapidly, until its use became general in the malaria-ridden Mediterranean countries. The tree was given the Latin name of *Cinchona*, in due respect to the Countess.

[4a] In Contrib. U. S. Nat. Herb. 23, pt. 1: 10-13, 1920, there is a fuller appreciative account of HERNANDEZ by P. C. STANDLEY.

With decreasing physical power the Spanish policy of the seventeenth and eighteenth centuries became one of jealous control over Spain's empire in the New World. Information concerning its resources was no longer published, but rather guarded as a state secret. So our next accounts of plants of Latin America (used as applying to all the New World south of the southern boundary of the continental United States), come from the non-Spanish portions thereof.

Commencing in 1637, the Dutch WILLEM PISO made observations of medicinal plants in the easternmost part of South America (from the states of Ceará and Rio Grande do Norte to Sergipe, Brazil), while with him was associated the German GEORG MARCGRAV whose observations were of broader scope; after their return to Holland in 1644 and MARCGRAV'S death that same year, PISO published at Amsterdam in 1648 twelve volumes entitled: "GULIELMI PISONIS de medicina brasiliensi libri IV, et GEORGII MARCGRAVII historiae rerum naturalium Brasiliae libri VIII," with a second edition ten years later. The northern portions of Brazil were then occupied by the Dutch.

Later in the Seventeenth Century came the investigation of the plants of the British West Indies by British botanists. For them botanical collecting and observation became a goal in itself, and no longer subsidiary to the medical potentialities the plants might possess. (Our further narrative will concern itself with botanical history in the more restricted sense.) First appears to have been JAMES HARLOW, who was sent to Jamaica in 1670 to gather living plants. In 1680 HENRY BARHAM commenced his Jamaica residence of nearly half a century, sending to SLOANE both plants and animals. But it was Sir HANS SLOANE (1660-1753) who made the British West Indies, and especially Jamaica, known to science. He was in the West Indies as a young physician (long before he was knighted) only from 1687 to 1689, but his report, published at London in two volumes in 1707, is a botanical classic. It is entitled: "A voyage to the islands Madera, Barbados, Nieves, S. Christophers and JAMAICA, with the Natural history of the herbs and trees, four-footed beasts, fishes, birds, insects, reptiles, & of the last of those islands . . . illustrated with the figures of the things describ'd . . . in large copper-plates as big as the Life." By the time this work appeared the young physician had become the Secretary of the Royal Society. An extensive introduction gives many observations, especially medical, but the plants are described and portrayed as objects of exact scientific information. SLOANE'S collections, which pertained to many fields of interest, were bequeathed to the British nation, and form a main foundation of the British Museum.

Just as the English by the late Seventeenth Century had acquired Jamaica and the Barbadoes from Spain, so had France gotten Haiti, with Martinique and other Lesser Antilles. To these islands came in 1689 two French botanists working together, CHARLES PLUMIER (1646-1704), a member of the Catholic order of the Minimi, and JOSEPH DONAT SURIAN (d. 1691). The latter returned to France in 1690 with a collection of dried specimens that is still preserved at Paris. PLUMIER did not collect such specimens, but instead made drawings and de-


PLATE 21. — Frontispiece of GEORG MARCGRAV'S *Historia Naturalis Brasiliae,* dedicated to Count JOAN MAURITZ VAN NASSAU-SIEGEN, Governor of Dutch Possessions in Brazil (1637-44), under whose auspices MARCGRAV and PISO made their collections and observations. — A Brazilian translation with an extensive, and authoritative commentary has recently been issued of this monumental work (São Paulo: Imprensa Oficial do Estado, 1942).

scriptions of the plants he saw and these form the basis of a series of works: "Description des plantes de l'Amérique," 1693; "Nova plantarum americanarum genera," 1703; with two further treatises on ferns in 1703 and 1705.

Another French member of the Minimi traveled much farther afield. LOUIS FEUILLÉE kept a journal in which by dated entries he recorded his observations; his three-volumed work published at Paris in 1714 bears the title: "Journal des observations physiques, mathématiques et botaniques, faites par l'ordre du Roy sur les côtes orientales de l'Amérique Méridionale. & dans les Indes Occidentales, depuis l'année 1707 jusques en 1712." But FEUILLÉE's greatest claim to botanical remembrance is his collecting on the western coast of South America, and his work at seaports of Chile and Peru in 1709 and 1710 yielded our first knowledge of the vegetation. He was longest at Concepción, Ilo, and Lima, and his journal includes an illustrated "Histoire des plantes médicales de Pérou et Chile."

Immediately after FEUILLÉE these coasts were again visited by a Frenchman, and AMADÉE FRANÇOIS FREZIER tells of them in his "Relation du voyage de la Mer du Sud aux côtes du Chily et du Pérou, fait pendant les années 1712, 1713 & 1714." He was eight months at Valparaiso and first learned to know central Chile, and he was especially interested in economic plants, giving the earliest figure of the large-fruited Chilean strawberry.

The art of illustrating made great advance over the preceding works in the paintings of the English naturalist, MARK CATESBY (ca. 1680-1749), who was on the Bahama Islands for at least the winter of 1725-26. His sumptuous work, based upon his travels, was entitled: "The natural history of Carolina, Florida and the Bahama Islands: containing the figures of birds, beasts, fishes, serpents, insects and plants . . . ," and was issued at London from 1731 to 1743.

The Scotch physician, WILLIAM HOUSTOUN, was in 1729 on Cuba, and from then until his death in 1733 on Jamaica, except for a visit to Vera Cruz and Campeche in 1730-31. He sent specimens and seeds to PHILIP MILLER in England, and thus many of HOUSTOUN's plants were first described in the various editions of MILLER's "Gardeners Dictionary." That tropical plants should appear in such a work shows the degree to which they were being grown in "stoves" or greenhouses. The dedication to LINNAEUS's "Hortus Cliffortianus" of 1737 tells of such greenhouses in Holland.

In 1745 an Irish physician, PATRICK BROWNE (ca. 1720-90), came to the British West Indies, where from 1746 to 1755 he gathered data toward a comprehensive study of Jamaica. This appeared in London in 1756 under the title: "The civil and natural history of Jamaica." In 1758 he sold his extensive herbarium to LINNAEUS, so that it is now included in the Linnean Herbarium that is under the care of the Linnean Society of London.

BROWNE's was the last considerable work on Latin American plants that used the old polynomial names for species. LINNAEUS' reform of 1753, when in the "Species Plantarum" he proposed his binomial system, was quickly adopted, and became universal in subsequent works.

Now, with the adoption of the binomial system of nomenclature at the middle of the eighteenth century, let us pause to see what portions of the New World were then known and what remained wholly unknown botanically. Because LINNAEUS intended to include in his book all plants then known to science, this becomes the most logical time for such a survey.

In North America, Quebec and Acadia, the British colonies along the Atlantic seaboard, and southern Mexico; in the West Indies, Jamaica, Haiti, the Bahamas, and British and French islands in the Lesser Antilles; in South America, eastern Brazil, a few seaports of the Caribbean Sea, and the coast of Peru and Chile are somewhat known, the most detailed attention having been given to Virginia and Jamaica. Against this the unknown includes the great interior valleys of the Mississippi, Orinoco, Amazon, and La Plata, with the mountain systems and plateau areas of both continents. Hardly were the Appalachians in their high portions visited as yet, nor the mountains of Brazil, let alone the western mountain ranges, the Rockies, the Sierras, and the Andes. Of the latter the Andes were destined to receive botanical study long before the corresponding mountains of North America.

In fact the northern Andes were already being traversed, although the specimens obtained were not identified until years later. As early as 1735 JOSEPH DE JUSSIEU (1709-74) had arrived in Ecuador on the La Condamine Expedition which had been charged with the exact measuring of a degree of the meridian. JUSSIEU studied plants, giving his attention first to *Cinchona*, but also gathering our earliest known specimens from the highlands of Ecuador. Later, he wandered over the Andean highlands and on their moist eastern slopes southward to Potosi in the present Bolivia, returning in 1755 to Lima where he lived until his return to France in 1771. Most of his specimens preserved at the Museum d'Histoire Naturelle at Paris are from Ecuador, although all are labeled simply "Pérou."

NICOLAUS JOSEPH VON JACQUIN (1727-1817), born in Holland but settled in Vienna, was from 1755 to 1759 on a mission for the Emperor collecting in the West Indies and at the Caribbean ports of South America. His elaborate folio works, describing and illustrating the plants obtained, appeared in Vienna from 1762 to 1780.

From about 1755 to 1770 FRÉDÉRIQUE ALLAMAND and DANIEL ROLANDER were in Dutch Guiana, and their collections formed the basis of LINNAEUS' paper of 1775 entitled "Plantae Surinamenses."

French Guiana received a much more significant study. FUSÉE AUBLET (1720-78), French, was sent thither officially as apothecary-botanist, reaching Cayenne in 1762 and returning to France in 1764. During a stay of exactly two years he made many drawings and preserved the specimens that together formed the basis for his four-volumed "Histoire des plantes de la Guiane Française," published in 1775.

Mention must be made of four wide-ranging voyages, on which parts of South America were casually visited. Two were under the French captain, L. A. BOUGAINVILLE. In 1763 he was along the southern Atlantic coast, at the Falkland Islands and the Strait of Magellan, and of this trip his chaplain PERNETTY wrote a report that was published at Paris in 1770. In 1767

BOUGAINVILLE was again in these seas, when the botanist PHILIBERT COMMERSON (1727-73) made collections in Uruguay, Argentina, Patagonia, at the Strait of Magellan, and on the Falkland Islands, collections now preserved at Paris. Similarly, the English captain, JAMES COOK, had scientific personnel on at least two of his voyages. In 1768 Sir JOSEPH BANKS (1743-1820) and DANIEL SOLANDER (1733-82), visited Rio de Janeiro and Cape Horn, but any collections there are but incidental to their more important work in New Zealand and at Botany Bay in Australia. On a succeeding COOK voyage that lasted from 1772 to 1775 JOHANN R. FORSTER and ANDERS SPARRMANN were on the Falkland Islands and for some time on Tierra del Fuego. For both voyages detailed scientific reports were prepared, but only the latter was then published; both are so largely beyond our territory as hardly to warrant further discussion.

A lone worker on the flora of the most remote part of Latin America was JUAN IGNACIO MOLINA (ca. 1738-1829), a Chilean who started zealously gathering materials for a natural history of his native territory. From the age of sixteen he was in Santiago, where he became a Jesuit father; and he was barely thirty when in 1768 there came the expulsion of the Jesuits by the liberal Spanish monarch, CARLOS III. MOLINA fled to Italy, where he lived for 55 years at Bologna, and there, as GIOVANNI IGNAZIO MOLINA, he published in 1782 his "Saggio sulla storia naturale del Chile," as an appendix to which appeared a "Flora selecta regni Chilensis," a comprehensive though brief summary of Chilean plants.

A momentous change in Spanish colonial policy was effected by CARLOS III. It was decided to have a survey made of the plant resources of the New World, through a series of governmental scientific exploring expeditions. The results were to be published. Such projects were planned for Peru and Chile, for New Granada, for Mexico, and likewise for the Philippines.

The "Expedición Botánica" to Peru and Chile was entrusted to HIPOLITO RUIZ (1754-1815), who was officially accompanied by JOSÉ PAVON (d. 1844), each of whom had a draughtsman assistant. Also, the French botanist JOSEPH DOMBEY (1742-94) was permitted to accompany them. The diary of RUIZ has fortunately survived, and has recently been published.[4b] It shows the day-by-day adventures, the successes and disasters, of the explorers from 1778 to 1788, the time that RUIZ and PAVON were in Peru, with a year and a half (1782-83) passed in Chile. In Peru they worked along the coast near Lima, and repeatedly crossed the Andes to collect on the moist eastern slopes as far as Huanuco, Tarma, and Huancayo. In Chile they worked mostly around Concepción, but journeyed northward to Santiago and Valparaiso. Much that they gathered was lost due to fire and shipwreck, but enough returned to Spain to form the basis of a series of imposing reports. But DOMBEY had returned in 1784, and much of his ten remaining years of life was spent in fretting about the restriction laid upon him not to publish botanical results of the journey ahead of RUIZ and PAVON, a request that seems just enough since the expedition was one sent out by the Spanish government; nevertheless some species were so published at Paris by L'HÉRITIER in his "Stirpes novae vel incognitae" of 1784-85, without DOMBEY's knowledge.[4c] The younger men, RUIZ and PAVON, worked more slowly, RUIZ publishing first an account of *Cinchona* under the title of "Quinologia, o tratado del árbol de la Quina o Cascarilla . . . "; and then jointly with PAVON "Florae peruvianae et chilensis Prodromus, sive novorum generum plantarum peruvianorum et chilensium descriptiones et icones" in 1794, "Systema vegetabilium florae peruvianae et chilensis, . . . " in 1798, and "Flora peruviana et chilensis, sive descriptiones et icones plantarum peruvianarum et chilensium . . . ," of which four volumes (the last of plates without accompanying descriptions) appeared from 1798 to 1802. The last work was the commencement of a great project that was discontinued as a result of the Napoleonic invasion of Spain. These works all appeared at Madrid, and the fullest series of RUIZ and PAVON's plants are preserved there.

The "Expedición botánica á Nueva Granada" remains famous in the history of Colombia, although it resulted in no formal report. Its intellectual stimulus came to an alert culture, and evidently through a remarkable personality, the cleric JOSÉ CELESTINO MUTIS (1732-1808). He reached Bogotá as early as 1760, and his collections sent therefrom to LINNAEUS in Sweden were described in the "Supplementum" to his father's works issued by the younger LINNAEUS in 1781. MUTIS failed to finish his own "Flora de Bogotá," but his herbarium has survived at Madrid.

Before telling of the Botanical Expedition to Mexico chronological accuracy requires our consideration of several workers in the West Indies and eastern South America. JULIUS P. B. VON ROHR (ca. 1737-93), a Dane, who was living from 1757 to 1791 on the island of St. Croix, collected also on Jamaica and Porto Rico, on the Lesser Antilles, and along the Caribbean coast of South America eastward to the Guianas; he was interested in economic plants and published a book on cotton. LOUIS C. M. RICHARD (1754-1821), French, was sent by his king in 1781 to Guiana, whence he traveled south to Pará at the mouth of the Amazon, and north to the Lesser Antilles, Porto Rico, and Haiti; he returned to France in 1789, but his collections seem to have resulted in no special work, even though he became one of the most profound botanical writers of his time. More important in his contributions to our knowledge of the West Indian flora is OLOF SWARTZ (1760-1818), a Swedish pupil of LINNAEUS, who may be considered as the great organizer of Antillean botany. In 1784 he was in Jamaica and Cuba, in early 1785 in Haiti, and then until his return to Europe in 1786 he was in Jamaica again. From 1788 to 1806 he published various books on the plants of the West Indies, the most comprehensive being a three-volumed "Flora Indiae Occidentalis aucta atque illustrata . . . " These appeared at Stockholm and Erlangen, but his collections are considerably scattered.

[4b] "Travels of RUIZ, PAVON, and DOMBEY in Peru and Chile (1777-1788)," translated by B. E. DAHLGREN, in Field Mus. Nat. Hist., Bot. Ser. vol. 21, 372 pp., 1940. This is from a manuscript preserved in Spain that was published at Madrid in 1931 by A. J. BARREIRO. I have also been shown a copy of RUIZ' Journal at the British Museum.

[4c] For DOMBEY's viewpoint see "JOSEPH DOMBEY . . . Sa vie, son oeuvre, sa correspondance . . . ," by E. T. HAMY, 434 pp., Paris, 1905. His plants are preserved at the Museum d'Histoire Naturelle at Paris.

In Brazil by 1790 the monk JOSÉ MARIANNO DE CONCEIÇÃO VELLOSO (1742-1811) had, with the aid of clerical and artistic helpers, completed his "Flora Fluminensis," a work that was published in 11 large folios in 1827. VELLOSO was born in Brazil, and his study of the flora of the vicinity of Rio de Janeiro seems singularly antiquated. A shorter work of his, of medical significance, entitled "Quinografia portugeza, ou Colleção de varias memorias sobre vinta e duas especies de quinas, tendentes ao seu descobrimento nos vastos dominios do Brasil . . . ," appeared at Lisbon in 1799.

The "Expedición Botánica á Nueva España" commenced its labors later than those to Peru and New Granada. In 1787 MARTIN SESSE (d. 1809), a Spanish physician and botanist, was appointed its director, with four assistants, one a draughtsman and another, VICENTE CERVANTES, a teacher. On May 1, 1788 a department of botany was established at the University of Mexico, and CERVANTES became professor of this subject until his death in 1829. He also had charge of the accompanying botanical garden. One of his earliest pupils was JOSÉ MARIANO MOCIÑO, a young Mexican physician who was in 1791 added to the scientific commission. SESSE and MOCIÑO cooperated in exploratory collecting until 1804, MOCIÑO travelling the more extensively, from sea-level to mountain heights, and from Guatemala on the south to California and Vancouver Island on the north. Together, SESSE and MOCIÑO went to Spain with their treasures, but, as it was with RUIZ and PAVON at the same period, the disrupted state of the country prevented publication of the manuscripts that they had prepared. After his colleague's death in 1809, MOCIÑO fell into disfavor with the Spanish patriots, who suspected him of complicity with the French, so in 1813 he fled to Montpellier in France, taking with him his Mexican manuscripts. There he lent these papers, with their many descriptions and illustrations, to AUGUSTIN PYRAMUS DE CANDOLLE; later, receiving permission from the authorities of a now independent Spain to return thither, he asked DE CANDOLLE at Geneva for the prompt return of his papers. DE CANDOLLE has told the romantic story of how he succeeded in obtaining copies of the drawings: "About 120 persons came voluntarily to offer me their time and brushes; most of them were ladies of society; but there were also professional artists and a multitude of persons who were strangers to me. The young people united in the common task. The whole city was busy for 10 days, and the diligence of all those who knew how to use a brush or pencil was really affecting." 860 drawings were copied completely, and 109 in outline only. Many species were published in various parts of DE CANDOLLE'S "Prodromus," but the manuscripts themselves were taken by MOCIÑO to Spain and disappeared after his death in 1819.

But SESSE and MOCIÑO'S plants were in Spain, and now JOSÉ PAVON, the sole survivor of the brilliant group of botanical explorers sent out by CARLOS III, evidently had them in charge. He distributed many of them, along with duplicates of his own, to various herbaria, labeled only in his own handwriting as "N. E." for "Nueva España." I have seen such at the British Museum and the University of Oxford. Bearing PAVON'S hand, it is not surprising that they have been attributed to PAVON as collector, although he was never in Mexico and these plants bear the peculiar names of the two published floras of SESSE and MOCIÑO.

These floras, which did not appear until many years after the deaths of their authors, are evidently not the works that they may be presumed to have elaborated in Spain. They are from manuscripts that remained in Mexico, and seem to be floras projected early in their career together. One is entitled "Plantae Novae Hispaniae" and the other "Flora Mexicana," and the Sociedad Mexicana de Historia Natural appended them to their journal "La Naturaleza" for the years 1887-90 and 1891-97, respectively. Mr. T. A. SPRAGUE in his critical discussion of them (with accompanying record of SESSE and MOCIÑO'S Mexican localities)[5] thinks that the "Plantae Novae Hispaniae" must have been prepared about 1792 and that the "Flora Mexicana," a more sketchy work, was not designed for the public at all. Their actual publication, after the lapse of a century, in their original form and unaccompanied by critical interpretation or reference to what had been described in the interim, has been as much of a botanical calamity as their appearance in the 1790s would have been a boon.

LUIS NÉE, French, and THADDAEUS HAENKE, Bohemian, were together on the Malaspina Expedition, a world-encircling voyage that lasted from 1789 to 1794. NÉE started with MALASPINA from Cadiz; HAENKE arrived a day too late, but, nothing daunted, set out in pursuit. While NÉE was collecting in Patagonia, on the Falkland Islands and in southern Chile, HAENKE reached Buenos Aires and crossed the southern Andes to Valparaiso, where the two botanists met in April, 1790. Thence they proceeded northward, stopping at various ports of Chile, Peru, Ecuador, and Mexico until the end of 1791, NÉE going inland at least to Canta from Lima and into Ecuador, while HAENKE visited Quito with the high peaks of Ecuador and also Mexico city. In January, 1794 HAENKE left the ships at Concepción in Chile, spent that year mostly in what is now northern Argentina and eastern Bolivia, then, after some time in La Paz, definitely settled in 1796 as a physician at Cochabamba. There he died in 1817, and his herbarium, transported to Prague in his native Bohemia, became the basis of C. B. PRESL'S "Reliquiae Haenkeanae" that appeared from 1825 to 1836.

Most famous of all scientific expeditions to tropical America has been that of Baron ALEXANDER VON HUMBOLDT (1769-1859) and AIMÉ BONPLAND (1773-1858), one that was planned with definite geographic goals. First, an investigation of the river-systems of inland South America led this German zoologist with his French botanical companion across the present Venezuela and up the Río Orinoco, thence through the Río Casiquiare that flows away from the upper Orinoco to join the upper Río Negro, a northern affluent of the Amazon. Returning again to the coast, they crossed to Cuba where the early months of 1801 were spent. Then, in order to study a tropical mountain-system, they again crossed the Caribbean Sea to Cartagena on the coast of the present Colombia, and there, in the course of Book XI, one loses the intimate

[5] "SESSE and MOCIÑO'S Plantae Novae Hispaniae and Flora Mexicana," in Kew Bull. Misc. Inform. 1926: 417-425.

touch of the "Personal Narrative"[6] that Humboldt later published. But, actually, the main portion of the travels was just beginning, and fortunately it is possible from a published record of localities to follow their route up the Río Magdalena, to Bogotá on the Eastern Cordillera of the Andes, across the Quindio Pass over the Central Cordillera to Cartago and up the Cauca Valley to Popayán, and thence on southward via Pasto to the present Ecuador which they entered about the beginning of 1802. The great Ecuadorian peaks were found so fascinating that more than half a year was given to visits to Antisana, Pichincha, Cotopaxi, Tunguragua, Chimborazo, and Assuay, so that it was August before the naturalists reached Ayavaca and Huancabamba in what is now northern Peru. Then they travelled more rapidly, and without attempting to climb more peaks, by Cajamarca and Trujillo to Lima, which they reached in early December. Thence, returning northward by boat they were in early January, 1803 at Guayaquil, Ecuador, from which they made an excursion over the lowlands toward Chimborazo, reaching the coast again by mid-February. By March 23 they were at Acapulco on the Pacific coast of Mexico, whence in April they travelled to Mexico city, making it their base for excursions northward to the present states of Hidalgo, Queretaro and Guanajuato, and westward to Morelia. Early in 1804 they went via Perote to Vera Cruz, from whence they crossed to Cuba, where they were in March and April. From Cuba they visited the United States, and finally reached France again in August, 1804.[7]

It is surprising what an influence this expedition had. In New Granada Francisco José de Caldas, the patriot-naturalist of Popayán and already a follower of Mutis, was affected by it, and members of old families of Popayán still speak of the Humboldt visit to that remarkable city. Scientifically, this expedition gave us our first clear understanding of problems of altitudinal and geographical alignment of vegetation, of the amazing wealth of ferns on moist tropical mountain-slopes, and many other botanical matters. Humboldt's figure remains permanently that of the master of philosophical observation. The botanical collections of Bonpland were numerous, and have been preserved both at Paris and Berlin. Even forms of microscopic life were gathered. Humboldt and Bonpland published jointly their botanical observations and reports. In 1805 appeared an "Essai sur la géographie des plantes; accompagné d'un tableau physique des régions équinoxiales, fondé sur des mesures exécutées depuis le dixième degré de latitude boréale jusqu'au dixième degré de latitude australe pendant les années 1799-1803." From 1805 to 1818 was issued a 2-volumed work descriptive of plants seen: "Plantae aequinoctiales, per regnum Mexici, in provinciis Caracarum et Novae Andalusiae, in Peruvianorum, Quitensium, Novae Granatae Andibus, ad Oronoci, Fluvii nigri, fluminis Amazonum ripas nascentes. In ordinem digessit Amatus Bonpland." From 1806 to 1823 was issued a 2-volumed "Monographia Melastomacearum" with exactly the same subsidiary information. But in 1816 Bonpland left France to became a settler in eastern Argentina far from the Andes. So Karl Sigismund Kunth was called in to prepare the actual text for the 7-volumed descriptive work entitled "Nova genera et species plantarum quas in peregrinatione ad plagam aequinoctialem orbis novi collegerunt, descripserunt, partim adumbraverunt Amatus Bonpland et Alexander de Humboldt. Ex schedis autographis Amati Bonpland in ordinem digessit Carol. Sigismund. Kunth. Accedunt . . . Alexandri de Humboldt notationes ad geographiam plantarum spectantes," issued at Paris from 1815 to 1825.

Antoine Poiteau (1766-1854), French, worked, especially with P. J. F. Turpin as artist, in Haiti from 1796 to 1800, when he left because of the negro insurrection. In 1813 they published together a Flora of the environs of Paris. From 1819 to 1822 Poiteau was in French Guiana.

The Napoleonic invasion of Spain in 1807 was quickly followed by a movement for independence throughout Spanish America, and by 1825 all the continental portions of it were freed. But in Portuguese America Brazil became the refuge of the court from Lisbon, and during these widely turbulent years its history was stable and progressive. The capital was moved from Bahia to Rio de Janeiro, where a botanical garden was established that functioned actively in the cultivation and diffusion of economic tropical plants throughout the country. And for several decades there came to Brazil a remarkable succession of able botanical explorers.

Georg Heinrich von Langsdorff (1774-1852), a German who had already been at Santa Catharina in 1803 on the Krusenstern Expedition, came in 1813 under Russian auspices, collecting until 1820 in Rio de Janeiro and Minas Geraes; when again in Brazil from 1824 to 1829 he travelled farther afield, to São Paulo and Matto Grosso and down the Rio Tapajoz to Pará. Another German, Friedrich Sellow (1789-1831), came in 1814 to Rio de Janeiro; until 1820 he collected from Bahia on the north to São Paulo, and then until 1830 worked farther south and also inland to Uruguay and Paraná, eventually dying in Minas Geraes. Adalbert von Chamisso (1781-1838), the poet and naturalist, with Johann Friedrich Eschscholtz (1793-1831), a fellow German, was on the Russian Romanzoff Expedition under Kotzebue that touched in 1815 at Santa Catharina, where according to Ehrenberg they gathered the first specimens of microscopic life, and presumably of Fungi too, known from Brazil; later, in association with D. F. L. von Schlechtendal, Chamisso published in Linnaea botanical results of his travels. From 1815 to 1817 yet a fifth German, Maximilian, Prinz zu Wied-Neuwied, collected objects of scientific and other interests from Bahia to Rio de Janeiro, the results appearing in his 2-volumed "Reise nach Brasilien in den Jahren 1815 bis 1817," published at Frankfurt in 1820-21. More intensive was the work of the French Auguste de Saint-Hilaire (1779-1853), who from 1816 to 1822 collected from Minas Geraes and Espirito Santo on the north to Goyaz and Paraná on the west, and to Uruguay on the south; his collections resulted in a series of papers published in Paris, culmi-

[6] "Relation historique . . .", Paris, 1814-1825. This unfinished journal was translated into English as "Personal narrative . . . ."

[7] Mr. T. A. Sprague has published in the Kew Bulletin of Miscellaneous Information detailed itineraries of Humboldt and Bonpland's routes as follows: Venezuela in volume for 1925, p. 295-310; Colombia, for 1926, p. 23-30; Ecuador and Peru, p. 181-190; and Mexico, for 1924, p. 20-27.

nating in his 3-volumed "Flora Brasiliae meridionalis" issued from 1825 to 1833.

But one who was destined to have a far greater influence on Brazilian botany than ST. HILAIRE followed him to that country the ensuing year. Supported by the Bavarian court and being the sixth German botanist to visit Brazil in this decade, KARL FRIEDRICH PHILIPP VON MARTIUS (1794-1868) reached Rio de Janeiro in July, 1817 and remained in Brazil till June, 1820. In three years he worked from Rio de Janeiro to Pará, and up the Amazon River to Alto Amazonas. His collections included all groups of flowering and flowerless plants. Returning to Germany where he continued to receive royal patronage, he brought out first jointly with the zoologist JOHANN BAPTIST VON SPIX their "Reise in Brasilien, auf Befehl Sr. Majestät Königs MAXIMILIAN JOSEPH von Bayern gemacht in den Jahren 1817-1820," issued in three volumes from 1824 to 1831; then an elaborate report on the palms seen, published from 1823 to 1845; then a 3-volumed work entitled like KUNTH's on the HUMBOLDT Expedition "Nova genera et species plantarum . . . "; and lastly and most comprehensive the monumental "Flora Brasiliensis . . . ", that with the aid of many contributing authors reviewed all that was known of the flora of Brazil. Its first part appeared in 1829 but it was not until 1906, many years after the death of its founder and with a total of 15 folio volumes, each of several independently bound parts, that the great task was completed.

The visits of two Bohemians, on an expedition sent by the Emperor of Austria, completes the roster of collectors of the Brazilian flora during this eventful decade. JOHANN CHRISTIAN MIKAN (1769-1844) of the University of Prague was at Rio de Janeiro in 1817-1818, and in 1820 published at Vienna his "Delectus Florae et Faunae Brasiliensis." His pupil, JOHANN EMANUEL POHL (1782-1834) was in Brazil from 1817 to 1821, collecting in the central states of Minas Geraes and Goyaz; on his return he published at Vienna a 2-volumed work, "Plantarum Brasiliae icones et descriptiones hactenus ineditae," from 1827 to 1831, and also his "Reise im Innern von Brasilien" from 1832 to 1837.

Perhaps 1820, in the midst of the wars of independence of Spanish America, is a good point at which to review again the progress of botanical interest throughout the Americas. The seventy years since 1750 have seen an enormous extension of the territory that had been at least visited. In North America the land from Quebec to Georgia is fairly known, and westward expeditions have crossed the Mississippi River to ascend the Missouri and Red rivers, and by the former one party has passed to the Pacific coast. Mexico has been more widely traversed, and maritime expeditions have visited points on the Pacific coast northward to Alaska. The West Indies have received further study. In South America a reconnaissance view of the vegetation of the Andes, both northern and southern, has been gained, and a surprisingly full knowledge achieved of the vegetation of Brazil and Uruguay. But on the southern continent the vast forests of the Amazon and Orinoco have been scarcely more than touched, and what knowledge of Andean vegetation has been acquired is merely a beginning of acquaintanceship with the flora there. The highlands of Guiana and Venezuela remain unknown. In the northern continent the vast tablelands and mountain ranges of the west remain unknown, and much still awaits physical as well as biotic exploration. On both continents these years have seen the beginning of botanical instruction, seemingly in the sequence of 1768 at Philadelphia[8], 1788 at Mexico city, and (presumably next) 1802 at Buenos Aires. But information of this kind is scattered, and it may be that instruction started equally early in the West Indies. By 1820 a number of botanical gardens were also in existence, but their actual histories (and whether they really functioned scientifically) is information not easy to obtain.

The thirty years remaining until 1850 were often turbulent over much of Spanish America, although in some countries the local governments steadied and strengthened. It might seem advisable to pursue from 1820 the separate course of botanical progress in each country, but so largely was the work accomplished by foreigners and so often did these visitors travel in more than one country, as to make it preferable to continue our method of general treatment. But Brazil will hold its separate course, and so will the Guianas and various West Indian islands. Through these thirty years there were many expeditions, both those sponsored by European governments and by private interests, and also there were individual resident collectors, persons engaged in mining or other interests. The more important of these will be mentioned in nearly chronological sequence.

CARLOS GUISEPPE BERTERO (1789-1831), Italian, was from 1816 to 1820 on the West Indies (Guadeloupe, Porto Rico, and Hispaniola), and in 1820-21 in northern Colombia (Santa Marta, Barranquilla, and the lower Magdalena valley), whence he returned via Jamaica to Europe. In 1827 he went to Chile, residing in Santiago and traversing central Chile from Aconcagua to Rancagua[9] until 1830, when for several months he visited the Juan Fernandez Islands and then Tahiti; in April, 1831 he started to return to Valparaiso, but the ship was lost. A study of his Chilean collections was published by LUIGI COLLA in the Memoirs of the Turin Academy for 1836.

From 1819 to 1825 JOHN MIERS (1789-1879), English, was in Argentina and Chile, and in 1826 there appeared in London his 2-volumed "Travels in Chile and La Plata." From 1826 he was in Argentina again, and from 1831 to 1838 at Rio de Janeiro, Brazil. Both trips contributed to his "Illustrations of South American plants," that appeared from 1846 to 1857.

AUGUSTE PLÉE (1787-1825), French, collected in 1820 and 1821 on the Lesser Antilles, in 1822 and 1823 on Porto Rico, in 1824 in coastal Venezuela, dying in 1825 on Martinique. As he had previously published on the French flora, it seems likely that his premature death interrupted a definite project of West Indian exploration.

CHARLES GAUDICHAUD-BEAUPRÉ (1789-1864), French, was pharmacist on three extended voyages, concerning the first and last of which he

[8] ADAM KUHN "was appointed professor of materia medica and botany in the College of Philadelphia (now the University of Pennsylvania), in January, 1768, and commenced his first course of botany in May following." Quoted from J. W. HARSHBERGER's "The Botanists of Philadelphia," p. 89, 1899. KUHN had been LINNAEUS's only American pupil.

[9] Publishing some of his novelties in the Chilean newspaper, Mercurio Chileno.

published botanical reports. From 1817 to 1820 he sailed on "l'Uranie" under Capt. FREYCINET, the course touching at Rio de Janeiro in 1817, and again at the Falkland Islands in 1820, whence on another ship "La Physicienne" he returned via Montevideo and Rio de Janeiro; the illustrated report of this expedition, mostly devoted to the islands of the Pacific and Indian oceans, appeared at Paris in 1826. GAUDICHAUD's second expedition was from 1831 to 1833 on "l'Herminie," and visited eastern Brazil, and Peru and Chile. His third expedition, in 1836 and 1837 on "La Bonite," again followed the South American coast, from Rio de Janeiro to Montevideo, around Cape Horn to Chile, Peru and Ecuador, and thence across the Pacific and Indian oceans; its elaborate report appeared in Paris in five volumes from 1844 to 1866. GAUDICHAUD was also author of extensive works on plant physiology and morphology.

Baron WILHELM FRIEDRICH VON KARWINSKI (1780-1855), Hungarian by birth but a Bavarian land-holder, was from 1821 to 1823 at Rio de Janeiro, Brazil. Later he was in Mexico, being from 1827 to 1832 in Oaxaca on behalf of a German-American society, and from 1840 to 1843 in Vera Cruz and other states for the Russian government.

WILLIAM JAMESON (1796-1873), Scottish, lived at Lima, Peru from 1820 to 1826, and then at Quito, Ecuador, until 1870. At Quito he was for many years professor of chemistry and botany in the University. He was the author of a 2-volumed, but unfinished, "Synopsis plantarum Aequatoriensium," published at Quito in 1865.

Continuing the exploration of Brazil, LUDWIG RIEDEL (1790-1861), German, arrived in 1821 and there spent nearly all the forty remaining years of his life. Until 1836 he collected for the Academy of Sciences of St. Petersburg, Russia, working over much of the country from Bahia to São Paulo, with a trip inland from 1826 to 1828 that crossed Matto Grosso and descended the Madeira and Amazon to Pará. His later collections, made under a Brazilian appointment, were fewer and mostly confined to Rio de Janeiro. With C. TAUNAY he published in 1839 a "Manual do agricultor brasileiro."

EDUARD FRIEDRICH POEPPIG (1798-1868), German, saw much of Latin America. From 1822 to 1824 he was on Cuba; then after a two years' visit to Pennsylvania, he was from 1827 to 1829 in Chile, and thence until 1832 in Peru and on the descent of the Amazon across Brazil to Pará, whence he returned to Europe. He published at Leipzig in 1835-36 his "Reise in Chile, Peru, und auf dem Amazonenstrome während der Jahre 1827-32," and with STEPHAN ENDLICHER a "Nova genera ac species plantarum . . . " for this same course. POEPPIG's collections included microscopic as well as macroscopic plants, as was also true of our next collector.

RAMON DE LA SAGRA (1798-1871), Spanish, also came to Cuba in 1822, but remained on the island until 1835, when he went to Paris to prepare his "Historia física política y natural de la isla de Cuba" that appeared in parts from 1842 to 1856. Two years later, in 1824, FRANCISCO ADOLFO SAUVALLE (1807-79), of French parentage but born in South Carolina, came to Cuba where he lived until his death fifty-five years later. SAUVALLE was the author of various papers on Cuban plants, and especially of a "Flora Cubana" that was published in Havana from 1868 to 1873.

JUAN LEXARZA, a native of Michoacán in southern Mexico, with PABLO LA LLAVE, a Spanish priest there, published in 1824-25 descriptions of some new genera of plants; these were especially of orchids, a group in which LEXARZA was especially interested.

JAMES MACRAE (d. 1830), evidently Scotch, for some time at the botanical garden on St. Vincent Island in the West Indies, was sent by the Horticultural Society of London from 1824 to 1826 on a collecting trip to Brazil (Rio de Janeiro and Santa Catharina), Chile (Valparaiso, Concepción, etc.), the Galapagos, and the Hawaiian Islands. He died as Superintendent of the Botanical Garden in Ceylon.

The voyage of Captain BEECHEY from 1825 to 1828 brought back to England the series of plants on which was based a report by W. J. HOOKER and G. A. W. ARNOTT that appeared in 1841. The collectors were GEORGE T. LAY who went as naturalist and ALEXANDER COLLIE as surgeon. The itinerary of the "Blossom" shows that it was at Rio de Janeiro, Brazil in July and August, 1825; Concepción and Valparaiso, Chile in October, 1825; San Blas, Mazatlán, and Acapulco, Mexico from December, 1827 to April, 1828 (with time spent by the botanists at Tepic); at Valparaiso and Coquimbo, Chile in May, 1828; and again at Rio de Janeiro, Brazil in August, 1828.

JOSEPH BARCLAY PENTLAND (1797-1873) from 1826 to 1828 investigated geologically and botanically the Titicaca Lake basin of southern Peru and Bolivia; and later, from 1836 to 1839, was British consul in Bolivia.

ALEXANDER CRUCKSHANKS, Scotch, collected near Santiago, Chile in 1826-27, and from Lima inland to Cerro de Pasco, Peru in 1829.

From 1826 to 1833 ALCIDE D'ORBIGNY (1802-57) was making the extensive collections of living and fossil plants, both macroscopic and microscopic, that resulted in the publication at Paris from 1834 to 1847 of his 9-volumed "Voyage dans l'Amérique méridionale." Arriving at Rio de Janeiro in September, 1826, he was from October, 1826 to January, 1827 in Uruguay; then until late in 1829 in Argentina; thence around Cape Horn and until May, 1830 in Chile; thence inland to the eastern slopes of the Andes in Bolivia (with a few months' excursion into Matto Grosso, Brazil in 1832) until June, 1833; then to coastal Peru until September, and to Valparaiso, Chile by October, 1833; and thence home via Cape Horn.

HUGH CUMING (1791-1865), English, went in 1819 to Chile, and from 1826 gave his life to amassing collections of animals and plants. A sailmaker by trade, he used a yacht and explored the coast from Chiloe northward, though also going inland to climb the Chilean Andes. In 1831 he visited the coasts of Ecuador, Colombia, Panama, and Jamaica. From 1836 to 1839 he made an extended voyage through the Pacific Islands and East Indies. His vast collections were taken to England for study.

JEAN LUIS BERLANDIER (d. 1851), Belgian, from 1827 to 1830 travelled extensively over northeastern Mexico, and then made his home at Matamoras on the southern side of the mouth of the Rio Grande. Thence he also explored southern Texas.

CARL AUGUST EHRENBERG (1801-49), a German and brother of the famous microscopist

CHRISTIAN GOTTFRIED EHRENBERG, was in 1827-28 on St. Thomas in the West Indies, from 1828 to 1831 in Haiti, and from 1831 to 1841 in Mexico where he worked near the capital and at Real del Monte in Hidalgo. His extensive collections include both animals and plants, and many minute forms were described by his brother. CHRISTIAN published two studies that summarized the knowledge of American microbiology up to that time: "Verbreitung und Einfluss des mikroskopischen Lebens in Süd-und Nord-Amerika"[10] in 1843, and "Mikrogeologie" at Leipzig in 1854.

CHRISTOPH WEIGELT, Dutch, was a collector in Dutch Guiana, for whom PULLE gives the year 1828.[11] More extensive collections from Surinam were made by F. W. HOSTMANN from 1824 to 1840, whose specimens share with WEIGELT's the distinction of being the earliest that have contributed to PULLE's recent work; HOSTMANN's collections, along with those of A. KAPPLER from 1841 to 1846 and in 1861, have been distributed by HOHENACKER.

CHRISTIAN JULIUS WILHELM SCHIEDE (1798-1836) and FERDINAND DEPPE (d. 1867), both German, began working together in southern Mexico in 1828. Their collecting was remarkably thorough, but was confined to the state of Vera Cruz which they studied from the seashore to the alpine heights of Orizaba. They worked especially near Mirador at the foot of Orizaba where KARL SARTORIUS, a political refugee from Germany, had already settled and where he was forming the large herbarium that on his death in 1872 was bequeathed to the Smithsonian Institution in Washington.

From 1828 to 1842 CLAUDE GAY (1800-73), French, made a comprehensive study of Chile that resulted in the publication at Paris of his "Historia física y política de Chile, segun documentos adquíridos en esta república durante doce años de residencia en ella y publicado bajo los auspicios del supremo gobierno." The botanical report, based largely on collections by the author but with the collaboration of various botanists, appeared in 1845. GAY's travels ranged from Coquimbo on the north to Chiloe on the south, with a visit to the Juan Fernandez Islands. Also, he collected in Peru in 1839-40.

THOMAS BRIDGES (1807-65) collected many American plants for Kew Gardens in his native England. From 1828 to 1842 he was in Chile, working in the Valparaiso district but with excursions south to Valdivia and north to Atacama; in 1844 he was again in Chile, collecting at Antofagasta and thence going inland to Bolivia. Years later he was in California and British Columbia.[12]

FRANZ JULIUS FERDINAND MEYEN (1804-40), German, was in Rio de Janeiro from September to November, 1830; thence he proceeded around Cape Horn so as to be in central Chile (Valparaiso to Coquimbo and inland) from January to March, 1831; then from Arica in late March and April he travelled extensively over southern Peru to Islay; and thence he proceeded to Callao and Lima, whence he crossed the Pacific Ocean to China, the Philippines, etc. His account of this journey was published in Berlin in 1834-35 under the title: "Reise um die Erde, ausgeführt auf dem Kön. Preuss. Seehandlungsschiffe Prinzess Louise, Capt. W. WENDT, in den Jahren 1830-32." But the brilliant author did not live to report on the plants collected, these being treated in a work by G. WALPERS and C. G. NEES VON ESENBECK in 1843. MEYEN made important contributions to the knowledge of plant geography and physiology, his "Grundriss der Pflanzengeographie . . ." appearing in 1836, his "Neues System der Pflanzenphysiologie" in 3 volumes from 1837 to 1839, and his "Pflanzenpathologie" after his death in 1840.

GEORGE URE SKINNER (1804-67), English, was a merchant who from 1831 made repeated visits to Guatemala where he assembled large collections of living orchids. He introduced many species to cultivation.

JAMES TWEEDIE (1775-1862), Scotch, migrated to Buenos Aires in 1825, and thence (chiefly from 1832 to 1837) collected much in central and northern Argentina, Uruguay, and southern Brazil.

ANDREW MATHEWS (d. 1841), an English gardener, appears to have first visited Valparaiso, Chile, but his important collections were made in Peru from 1833 until his death. He worked in central and especially in northern Peru, his collections often being the first for species endemic to this portion of the Andes.

KARL MORITZ (1797-1866), German, came in 1834 to the West Indies, where he collected on the Virgin Islands and then in 1835 on Porto Rico. But his important work was in Venezuela from 1835 to 1837, where he was mostly in the states of Merida and Trujillo and made the first considerable collections from the Venezuelan Andes. In 1840 he came again to Venezuela, settling at Colonia Tovar and then until his death at La Guayra.

CHARLES DARWIN (1809-82), the English naturalist, on the world cruise of the "Beagle," was in 1834 in Patagonia and on Tierra del Fuego, on the Chonos Archipelago and on Chiloe, then in 1835 at Chilean and Peruvian ports, and on the Galapagos Islands. After contributing his portion to the report of the expedition published by the British admiralty in 1839, he issued separately his "Voyage of a naturalist around the world" and in 1846 his "Geological observations on South America." DARWIN's plant collections, which included all forms of life macroscopic or microscopic, have contributed especially to our knowledge of the Patagonian and Magellan floras.

In 1836 JOACHIM VELASQUEZ, a Mexican officer, took to Italy a small collection of dried plants and seeds gathered in Guatemala, and these became the basis of a "Florula Guatimalensis" by ANTONIO BERTOLINI that was published in the journal of the Academy of Bologna in 1840.

ROBERT SCHOMBURGK (1804-65), of a German merchant family, was in the West Indies (St. Thomas, Porto Rico, Tortola, and Anegada) from 1829, but his distinguished work for the Geographical Society of London commenced in 1835. From 1835 to 1839 he made a comprehensive exploration of British Guiana, also crossing into northernmost Brazil to the Río Branco and

[10] In Abhandl. Akad. Wissensch. Berlin 1841: 291-446, tab. 1-4, 1843.

[11] As stated in the "Provisional Introduction" to his "Flora of Surinam," Amsterdam, 1932. A series of WEIGELT's specimens, credited in SCHWEINITZ' hand to CONSTANTINE HERING who had brought them to Philadelphia, is at the Academy of Natural Sciences; that SCHWEINITZ really understood the situation is shown by this entry in the manuscript catalogue of his herbarium: "HERING Dr. Surinam—innumerae WEIGELT collect."

[12] "The botanical activities of THOMAS BRIDGES," by IVAN M. JOHNSTON, in Contrib. Gray Herb. 81: 98-106, 1928.

even to the Río Casiquiare in southern Venezuela. This expedition resulted in "A description of British Guiana, geographical and statistical . . .", and in his "Reisen in Guiana und am Orinoko während der Jahre 1835-1839 . . .", which was published in Leipzig in 1841. On a second expedition from 1840 to 1844 he was commissioned to map or survey the boundaries of British Guiana, and this took him to the alpine heights of Mount Roraima; on this project he was accompanied by his brother RICHARD SCHOMBURGK (1811-1891) on behalf of the King of Prussia, and RICHARD wrote his "Reisen in Britisch-Guiana, in den Jahren 1840-1844 . . ." which appeared in two volumes at Leipzig in 1847 to 1848. The collections obtained on both journeys included all forms of life, microscopic as well as macroscopic, from the discovery of *Victoria regia* to that of diatoms. For his work ROBERT was knighted in England, while RICHARD had a long and distinguished career as Director of the Botanical Garden at Adelaide in Australia.

From 1835 to 1840 a group of botanists under Belgian auspices were actively investigating the flora of southern Mexico; several of them also worked in Central and northern South America. Foremost was the French HENRI GALEOTTI (1814-58), who arrived in 1835 and before returning to Belgium in 1840 had traversed the territory from Vera Cruz to San Luis Potosi, Tepic, and Oaxaca, his being historically the most important collection from Oaxaca. AUGUST B. GHIESBREGHT (1810-1893), Belgian, collected with LINDEN and FUNCK, but after 1840 worked alone, living in Tabasco and then in Chiapas; although repeatedly visiting Europe, GHIESBREGHT spent many years in Mexico. JEAN JULES LINDEN (1817-98), Belgian, collected in many parts of Latin America, before he commenced his long career as owner of famous nurseries in Ghent. From 1835 to 1837 he worked in Brazil from Rio de Janeiro to Minas Geraes and São Paulo; from the end of 1837 to early 1838 in western Cuba; from March, 1838 till early 1841 in eastern Mexico (Vera Cruz to Mexico city), Yucatán, and northern Guatemala; from the end of 1841 to 1844 in Venezuela and Colombia (from the coast of Venezuela inland to Mérida, and of Colombia to Bogotá and Cartago, as well as on the Sierra Nevada de Santa Marta); after March, 1844 in Jamaica and Cuba again, with return to Europe late in the year. Finally, LINDEN'S artist, NICOLAS FUNCK (1816-96), likewise Belgian, after accompanying him on most of the course just outlined, collected with LOUIS JOSEPH SCHLIM in 1845 on Guadeloupe of the Lesser Antilles, in Venezuela, and in northeastern Colombia.

GEORGE GARDNER (1812-49), Scotch, was in Brazil from 1836 to 1841, where he collected from Rio de Janeiro northward to Ceará and Maranhao. In 1846 appeared his 2-volumed "Travels in the interior of Brazil, principally through the northern provinces and the Gold and Diamond districts, during the years 1836-1841." He later had charge of the botanical garden at Peradeniya, Ceylon. His Brazilian collections, preserved at Kew Gardens, have contributed much to our knowledge of the drier provinces of northeastern Brazil.

From 1836 to 1842 occurred the voyage of the "Sulphur," a British scientific expedition under command of Sir EDWARD BELCHER whose "Narrative" of the voyage appeared in 1843. Botanical collections were made from 1836 to 1839 on the Pacific coast of America in California and from Mexico to Ecuador; these were gathered both by RICHARD B. HINDS, surgeon, and by GEORGE BARCLAY. "The Botany of the Voyage of H.M.S. Sulphur," edited by HINDS and with descriptions by GEORGE BENTHAM, was published in 1844.

THEODOR HARTWEG (1812-71), German by birth, collected for the Horticultural Society of London from 1836 to 1843, and again from 1845 to 1848. During the first period he visited Mexico (territory from Vera Cruz to Zacatecas, Michoacán, and Oaxaca), Guatemala, Ecuador (Guayaquil to Pinchincha and Loja), Colombia (at Popayán and Bogotá, and on the Río Magdalena), and Jamaica. During the second period he crossed Mexico from Vera Cruz to Mazatlán and proceeded to California.[13a]

The United States Exploring Expedition, under command of CHARLES WILKES and having as botanical collectors CHARLES PICKERING, WILLIAM RICH, and J. D. BRACKENRIDGE, enters slightly into our consideration due to its having worked in Patagonia, on Tierra del Fuego, and also at Valparaiso and Callao, apparently all in 1839.[13b]

More significant was the work accomplished by JOSEPH D. HOOKER (1817-1911) on the Ross Antarctic Expedition, a British undertaking, when from April to December, 1842 he collected all forms of plant life on the Falkland Islands, with the intermission of nearly two months on Hermite Island, Fuegia; the flora of each area was reported in Ross' "A Voyage of discovery and research in the Southern and Antarctic regions, during the years 1839-43," published in 1847.

FREDERIK MICHAEL LIEBMANN (1813-56), Danish, was in southern Mexico from 1841 to 1843, working especially from Vera Cruz to Tehuantepec and Oaxaca. His large collections, on which he was publishing assiduously until his early death, are at Copenhagen.

WILLIAM PURDIE (1817-1857), Scotch, was in 1843 in Jamaica, thence going in 1844 to Santa Marta, Colombia, so as to climb the Sierra Nevada de Santa Marta. His still remain our most ample collections from this isolated mountain-system. Thence in 1844-45 he worked inland to Bogotá. In 1846 he succeeded DAVID LOCKHART as Superintendent of the Botanical Garden on Trinidad. In 1851 he collected in the interior of Venezuela.

In 1843 there came to South America the man who was to organize for the first time our knowledge of the plant-life of the Andes. HUGH ALGERNON WEDDELL (1819-77), English by birth, was "voyageur-naturaliste" on a scientific expedition under FRANCIS DE CASTELNAU, and he contributed to the latter's report entitled "Expédition dans les parties centrales de l'Amérique du Sud, de Rio-de-Janeiro à Lima, et de Lima au Para, exécutée par ordre du gouvernement français pendant les années 1843 à 1847" a botanical study in two volumes entitled "Chloris Andina, Essai d'une flore de la région alpine des

[13a] A report of his collections, by GEORGE BENTHAM, entitled "Plantae Hartwegianae," was issued from 1839 to 1857.

[13b] From 1841 to 1874 ANDERS FREDRIK REGNELL (1807-84), Swedish, lived as physician in Minas Geraes, Brazil, besides his own extensive collections, his legacy to the Stockholm Academy of Science has made possible the more recent expeditions of C. A. M. LINDMAN and G. O. A. MALME.

Cordillères de l'Amérique du Sud" that bears date of 1857. WEDDELL's own collections were made from 1843 to 1845 in Brazil (Rio de Janeiro and Minas Geraes to Matto Grosso); from August, 1845 to January, 1847 in Bolivia; then about Lake Titicaca in either Bolivia or Peru until June; then across southern Peru to Islay, thence to Lima, and finally home around Cape Horn. But under other auspices WEDDELL was enabled to return to Bolivia in 1851, entering from Arica and returning to Islay on the Peruvian coast. Both expeditions contributed to the "Chloris Andina."

Also there should be mentioned JULIUS VON WARSCEWICZ, a Polish collector of humming-birds and orchids, who came to Guatemala in 1846, whence he proceeded through Salvador, Nicaragua, and Costa Rica to Panamá.

The most important botanist of Central America, ANDERS SANDÖE OERSTED (1816-72), Danish, was in Nicaragua and Costa Rica from May, 1846 to July, 1848. He was professor in the University of Copenhagen, and published a succession of papers on Central American plants in the Videnskabelige Meddelelser from 1852 to 1861.

The British scientific expedition of the ship "Herald" actually began in June, 1845 and had followed both coasts of South America when its botanical interests met disaster in the accidental death in Ecuador of the collector, THOMAS EDMONSTON; but the real importance of the expedition commenced with the arrival of his successor at Panamá in September, 1846. BERTHOLD SEEMANN (1825-71), German by birth, collected in Panamá until the following April, there joining the boat's party on its return from a northern cruise in January, 1847; he was with the ship from May, 1847 to February, 1848 when by charting the coast from Callao to Panamá it brought to completion the British Admiralty's survey of South American shores; then he took part in an Arctic cruise, next collecting in Panamá early in 1849; and, finally, while a survey was being made of the Gulf of California from November, 1849 to March, 1850, he made an inland journey through the Mexican states of Sinaloa, Durango, and Jalisco. From 1852 to 1857 was published "The Botany of the Voyage of H.M.S. Herald," wholly by SEEMANN; this comprised four floras, of which those "of the Isthmus of Panama" and "of North-Western Mexico" pertain to our present sketch. SEEMANN also published both an English and a German account of his travels; these appeared in 1853, that in English being entitled "Narrative of the Voyage of H.M.S. Herald."

From 1846 to 1848 occurred the war between the United States and Mexico, as a consequence of which all northern Mexico of that time, Texas, New Mexico, and California passed to the former country. United States army surgeons and others made collections in what has since constituted northern Mexico, the most extensive botanical report being on the plants collected by ADOLPH WISLIZENUS (1810-89) in Chihuahua. This was published officially in 1848 as a "Memoir of a tour to northern Mexico, connected with Col. DONIPHAN's Expedition, in 1846 and 1847," and contains a "Botanical Appendix" by GEORGE ENGELMANN. After the war a commission of both governments was appointed to survey the new boundary line, and to it the United States government attached several plant collectors. The work of this survey, with the addition of that required by the Gadsden Purchase of 1853, lasted from 1849 to 1855, and during most or all of this time JOHN M. BIGELOW (1804-78), CHARLES C. PARRY (1823-90), ARTHUR SCHOTT (1814-75), GEORGE THURBER (1821-90), and CHARLES WRIGHT (1811-85) were collecting the specimens on which was based JOHN TORREY's report of 1858 entitled "The Botany of the Boundary." While pertaining mainly to what is now United States' territory, this included much from adjacent Mexico.

Finally, from 1848 to 1852, ALFRED RUSSEL WALLACE (1823-1913), English and chiefly known as a zoologist, was in the Amazon valley of Brazil. In 1853 he published "A narrative of travels on the Amazon and Rio Negro . . .", and also a book on "Palm trees of the Amazon and their uses."

We have now reached 1850, the year set as the limit for this historical sketch. We have seen an ever increasing interest in the scientific knowledge of the plants of Latin America, a development quite like that in other parts of the World. For Latin America this had reached by 1850 the stage of extensive and fairly sustained exploration, a stage then passed only in western Europe and eastern North America by that of the formation of reasonably complete "Floras." In 1850 western temperate North America was but at the beginning of such exploration.

More than ninety years have passed since 1850, and western temperate North America is now so well known that there the stage of simple exploration has passed into that of the development of adequate "Floras." But over Latin America the need of much more exploration everywhere persists. The era of prolonged expeditions ended in the nineteenth century, and now there are either shorter ones that from a collecting standpoint are more efficient or else resident botanists are carrying investigation forward. But remote parts of the Andes and of the Pacaraimas, the vast valleys of the Amazon and Orinoco, still need well organized expeditions for their satisfactory penetration. The total flora of South America is far richer in species than that of the northern continent.

There are many other aspects of botanical investigation than that of acquainting ourselves with the occurrence of species in nature and their distribution, and readers may be disappointed that I have told so wholly of such exploration. But these other manifold kinds of botanical study, from morphology to physiology and genetics, come later, and scarcely were they existent in Latin America by 1850. Moreover, there is warrant for pressing first the task of exploration, as upon its completeness other aspects, both of pure and applied science, wait. Man's botanical survey must be completed before he can fully know the resources of this globe on which he lives.

**The scope of the present volume calls for at least the mention of the most outstanding work since 1850. This will be given by countries.**

***Mexico.*** **— The most important exploration of the later nineteenth century was done by botanists from the United States. Most notable among these were EDWARD PALMER (1831-1911) and CYRUS G. PRINGLE (1838-1911), who used the railroad in traveling widely over Mexico north of the Isthmus of Tehuantepec. Both were collectors, who left to others the study of what they gathered — PRINGLE being the greatest of all collectors of the Mexican flora. Such collecting was continued, especially in the first decade of this century, by JOSEPH**

N. ROSE (1862-1928)[13a] and PAUL C. STANDLEY, the former being joint author with NATHANIEL L. BRITTON of "The *Cactaceae*" from 1919 to 1923 and the latter of "Trees and Shrubs of Mexico," issued from 1920 to 1926.

*British Honduras.* — This has been botanically neglected, until the recent work by botanists of the Field Museum of Chicago and of the University of Michigan. In 1936 appeared "The forests and flora of British Honduras" by PAUL C. STANDLEY and SAMUEL J. RECORD, and studies by CYRUS L. LUNDELL are covering this with adjoining territory in Guatemala and Mexico.

*Guatemala.* — Collections were made in the later nineteenth century by and for JOHN DONNELL SMITH (1829-1928), who published many descriptions from this and other Central American countries, beside issuing separately an enumeration of the Guatemalan flora. At present P. C. STANDLEY and his associates of the Field Museum of Natural History are collecting toward an actual Flora.

*Salvador.* — This was little visited until the work of PAUL C. STANDLEY during the last twenty-five years. In 1925 he and SALVADOR CALDERÓN published a "Lista preliminar de las plantas de El Salvador."

*Honduras.* — This republic is botanically the most neglected portion of the New World. In 1931 P. C. STANDLEY published an annotated enumeration of the plants of the Lancetilla Valley[14], but it will be long before enough has been collected to warrant an actual Flora of the country.

*Nicaragua.* — Except for species that appear in OERSTED'S and J. D. SMITH'S papers, this country has remained little known botanically. In 1911 there appeared at Managua a 2-volumed "Flora Nicaraguensis"[15] by MIGUEL RAMÍREZ GOYENA.

*Costa Rica.* — This is the best-known of Central American republics. Since the time of OERSTED the most important collecting has been done by JOHN DONNELL SMITH and HENRI PITTIER, both contributing to the latter's "Primitiae Florae Costaricensis"[16] and the latter author of an "Ensayo sobre las plantas usuales de Costa Rica;" and by PAUL C. STANDLEY, who published in 1937 and 1938 a detailed enumeration of the flowering plants that was entitled "Flora of Costa Rica."

*Panama.* — Since SEEMANN'S time little attention has been given to the plants of Panamá until recent years. In 1928 PAUL C. STANDLEY published his "Flora of the Panama Canal Zone," and now botanists of the Missouri Botanical Garden, especially ROBERT E. WOODSON and R. J. SEIBERT, are making collections toward a Flora of the whole republic.

*West Indies.* — From 1856 to 1867 CHARLES WRIGHT (1811-85), who had previously been the most active collector on the United States-Mexican Boundary Survey, worked nearly constantly in Cuba, the results of his labors being embodied in A. GRISEBACH'S "Catalogus plantarum Cubensium exhibens collectionem Wrightianum aliasque minores ex insula Cuba missas," published at Leipzig in 1866. GRISEBACH had already written his "Flora of the British West Indian Islands" that appeared at London in parts from 1859 to 1865. He was never in the West Indies himself, nor apparently was his fellow German, IGNATIUS URBAN, who through his great serial "Symbolae Antillanae seu Fundamenta Florae Indiae Occidentalis," in 9 volumes from 1898 to 1928, contributed more than any other to our knowledge of the West Indian flora. In contrast to GRISEBACH and URBAN, NATHANIEL LORD BRITTON (1859-1934) from 1901 on made many collecting trips to the islands; he published in 1918 a "Flora of Bermuda," in 1920 with CHARLES F. MILLSPAUGH "The Bahama Flora," from 1923 to 1930 jointly with PERCY WILSON the account of Spermatophytes in the "Botany of Porto Rico and the Virgin Islands," while for many years he collaborated with Frère LEÓN of Havana upon a "Flora of Cuba" that remains as yet unpublished. Mention should also be made of the zealous collecting in Cuba and Haiti of ERIK L. EKMAN (1883-1931), whose plants were being reported by URBAN until the death in the same year of both collector and reporter. Since 1928 R. O. WILLIAMS and E. E. CHEESMAN have been issuing in parts a "Flora of Trinidad and Tobago," and since 1935 HENRI STEHLÉ a "Flore de la Guadeloupe et Dépendances."

*Colombia.* — JOSÉ TRIANA (1834-90), a native Colombian, in association with J. E. PLANCHON, published at Paris in 1862 the first volume of a "Prodromus Florae Novo-Granatensis," while a second, appearing in parts from 1863 to 1867, contained contributions by various European botanists on Lichenes, Bryophyta, and Pteridophyta; but the work was only the beginning of a great project. In the succeeding fifty years little collecting or special study was made of Colombian plants, but for some thirty years now collections from that country have been increasing and ELLSWORTH P. KILLIP, who has himself worked in several parts of Colombia, is hoping to develop a "Flora of Colombia." Quickened interest has resulted from the foundation in 1934 of the Academia Colombiana de Ciencias Exactas, Físicas y Naturales, with a scientific museum at Bogotá, and with its Revista and the journal Caldasia as mediums of publication. ARMANDO DUGAND and JOSÉ CUATRECASAS are the ablest of the new group of Colombian botanists.

*Venezuela.* — In spite of the physical diversity and richness of the country, botanical progress has been slight. It has, however, been stimulated by the residence there since 1917 of HENRI PITTIER, who, just as he had done for Costa Rica, has published for his newly adopted land a "Manual de las plantas usuales de Venezuela" (1926). A remarkable bit of recent exploration was G. H. H. TATE'S ascent of Cerro Duida, at the western extremity of the Guiana-Venezuelan mountains and close to the upper Orinoco, where from October, 1928 to March, 1929 his party collected a flora nearly wholly unknown. The "Botanical results of the Tyler-Duida Expedition," by HENRY A. GLEASON, appeared in 1931 in the Bulletin of the Torrey Botanical Club.

*Guiana.* — Some collections have of late years been assembling from British Guiana, but it is in Dutch Guiana that most recent progress has been made. A. PULLE, who collected there in 1920, had long been publishing upon the flora, and from 1932 has been issuing at Amsterdam his detailed "Flora of Surinam."

*Ecuador.* — Although its high mountains have attracted geological and other expeditions, there is as yet no comprehensive Flora of the country. LUIS SODIRO (1836-1909), an Ecuadorean Jesuit, collected over many years, and published his "Apuntes sobre la Vegetación Ecuatoriana" at Quito from 1874 to 1908. LUDWIG DIELS, of the Berlin Botanical Garden, visited Ecuador in 1933, and in 1937 there appeared his "Beiträge zur Kenntnis der Vegetation und Flora von Ecuador," containing an ecological study, historical accounts of collectors, and descriptions of new species.

*Peru.*—After the work of WEDDELL about 1850 came the geographical labors of ANTONIO RAIMONDI, who also made many collections of plants which have only recently been receiving adequate study in Germany. In 1901 AUGUST WEBERBAUER came from Germany to Peru, where he has now lived for many years at Lima. He has made an intimate study of the Peruvian flora. His many collections have mostly gone to Germany, where they were reported by various taxonomists in the series "Plantae . . . . Weberbauerianae," while he himself published in 1911 his "Pflanzenwelt der peruanischen Anden."[17] His later collections have gone to the Field Museum of Natural History where since 1936 J. FRANCIS MACBRIDE has been issuing parts of a comprehensive "Flora of Peru." MACBRIDE has himself collected in Peru, especially in the territory visited by RUIZ and PAVON in the eighteenth century.

*Bolivia.* — The flora of Bolivia remains little known. Since 1880 there have been several visiting botanists:

[13a] For his study of *Cactaceae* Dr. ROSE visited nearly all countries of Latin America, as did also ALBERT S. HITCHCOCK (1865-1935) for grasses.

[14] As Vol. 10 of Bot. Ser. of Publ. Field Museum of Natural History.

[15] Erroneously written "Flora Nicaraguense."

[16] By TH. DURAND and H. PITTIER, the first and second parts appearing in Bull. Soc. Bot. Belg. for 1891 and 1892, and the third and fourth at San José in 1898 and 1907. The last was actually by J. D. SMITH.

[17] "Plantae novae andinae imprimis Weberbauerianae" appeared in the Jahrb. Syst. Bot. from 1906 to 1913; "Pflanzenwelt . . ." as vol. 12 of Die Vegetation der Erde.

HENRY H. RUSBY (1855-1940), North American, in 1885, who later described from his own and other collections many Bolivian species; and TH. HERZOG, German, in 1907-08 and again in 1910-11, who in 1923 published his "Pflanzenwelt der bolivischen Anden und ihres östlichen Vorlandes."[18] As with WEBERBAUER, many new species have been based on HERZOG'S collections, while his own contributions have been devoted chiefly to the Bryophyta.

*Brasil.* — From 1849 to 1855 RICHARD SPRUCE (1817-93), English, studied the vegetation of the Amazon Valley in Brazil, excepting for an excursion from March, 1853 till early 1855 to the middle Río Orinoco in Venezuela; from May, 1855 to 1864 he was in Ecuador. Although his collections were ample and mostly of arborescent vegetation, his own interest turned to the Bryophyta and to the elucidation of these his remaining life was devoted. Other collectors in Brazil have been numerous, such as JOÃO BARBOSA RODRIGUES (1842-1909), Brazilian, who from 1868 collected widely over Brazil; EUGENIUS WARMING (1841-1924), Danish, from 1863 to 1866 in Rio de Janeiro, most famous for his writings on ecology; SPENCER L. M. MOORE (1851-1931), English, who in 1891-92 went from Argentina through Paraguay into Matto Grosso; PER K. H. DUSÉN (1855-1926), Swedish, who from 1902 to 1904 was in southern Brazil; FRITZ MÜLLER (1822-97), German, who lived from 1852 on in the state of Santa Catharina, and whose keen observations of flower-pollination[19] are famous; and ERNST H. G. ULE (1854-1915), German, who from 1883 to 1903 was in the southern provinces and then in the Amazon valley. Active today are ADOLFO DUCKE, JOÃO G. KUHLMANN, and ALBERTO JOSÉ DE SAMPAIO of Rio de Janeiro, and F. C. HOEHNE of São Paulo; the last has commenced the preparation of a second great Flora of Brazil, to be known as the "Flora Brasilica."

*Paraguay.* — This was almost unknown botanically until the work of EMILE HASSLER (d. 1937), Swiss, whose ample collections from 1885 to 1900 were reported by ROBERT CHODAT in the Bulletin of the Boissier Herbarium from 1898 to 1905.

*Uruguay.* — Scientific activity received a great stimulus from the establishment of the Museo Nacional de Montevideo, the first number of the Anales of which appeared in 1894. It contained a study of Uruguayan grasses by JOSÉ ARECHAVALETA, and his papers have continued to be leading contributions to our knowledge of the Uruguayan flora.

*Argentina.* — The scientific life of Argentina has been highly institutionalized. The Museo Nacional de Historia Natural in Buenos Aires was founded in 1823, and its Anales have been running from about 1890. About 1870 there was a great quickening of intellectual interests throughout Argentina under the presidency of SARMIENTO. It was then that the Academia Nacional de Ciencias was founded at Córdoba, and PAUL GUNTHER LORENTZ (1835-1881), a German bryologist, was invited to become professor of botany; his extensive collections from the provinces of Córdoba, Santiago, Tucumán, and Chaco in central and northern Argentina were the bases of GRISEBACH'S "Plantae Lorentzianae" (1874) and "Symbolae ad Floram Argentinam" (1879), published in Germany. In 1872 the Sociedad Científica Argentina was founded in Buenos Aires, and its Anales have been running since 1876. The Museo de la Plata at the city of La Plata commenced with collections given to the Universidad in 1877, but by 1890 established its own Revista. The journal Physis, devoted to natural history, commenced in 1912. Through all these media we have many papers upon the Argentine flora, from such comprehensive taxonomic and floristic ones as those of LUCIEN HAUMAN to papers by LORENZO R. PARODI on grasses and by CARLOS SPEGAZZINI on Fungi. In 1922 CRÍSTOBAL M. HICKEN added yet another journal, Darwiniana, to those published at or near Buenos Aires. But other centers have also become active. To the northwest the Academia Nacional de Ciencias flourishes at Córdoba, while beyond it at Tucumán is the Instituto Miguel Lillo that sponsors, under the editorship of the botanist HORACIO R. DESCOLE, the journal Lilloa, commenced only in 1937. Strong as are all these institutions one notices the absence of definite Floras or of an effort to bring out a unified account of the plant-life of Argentina.

*Chile.* — The botanical activity is much less diversified than in Argentina, and has been strongly individualistic. In fact, a single figure dominated Chilean botany during the second half of the nineteenth century. From his arrival in 1851 as a political refugee from Germany for some fifty years RUDOLFO AMANDO PHILIPPI (1808-1904) described thousands of plant-species from Chile. The fact that his types are mostly preserved at the Museo Nacional at Santiago makes Chile unique among Latin American countries in having the majority of the type-specimens of its flora preserved in the country itself. But PHILIPPI did not develop actual taxonomic revisions, and it later devolved on CARLOS REICHE in his "Flora de Chile," commenced in 1896 and left unfinished when its author left the country in 1911, to provide comparative presentations of the species with keys for their identification. REICHE, like WEBERBAUER for Peru and HERZOG for Bolivia, contributed to Die Vegetation der Erde a floristic summary, and this he entitled "Grundzüge der Pflanzenverbreitung in Chile."[20]

THE ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, PA.

JESÚS PATIÑO NAVARRETE: **La Agricultura y los Recursos Vegetales de México:** — La Agricultura ocupa en México una posición de la más elevada importancia, desarrollándose fundamentalmente para el sostenimiento de su población.

El territorio de los Estados Unidos Mexicanos está comprendido entre los paralelos 14°, 33′ y 32°, 43′. Sus tierras son atravesadas por dos altas cordilleras, bifurcación de la gran cordillera Andina y continuadas después por las montañas Rocallosas y las Sierras Costaneras de Estados Unidos por el Oeste y los Montes Apalaches por el Este. Están unidas ya en el territorio Mexicano por numerosos contrafuertes, determinando una variación muy importante en la configuración del territorio que origina una gran diversidad de climas. De los 32 tipos de climas que se consideran en el mundo, 18 tipos perfectamente definidos se encuentran en México, aún cuando de éstos sólo siete se hallan representados en regiones mayores del 5% de su área total.

Los terrenos agrícolas de México están por lo tanto situados, entre las latitudes ya mencionadas, a muy diferentes altitudes; destacándose de manera prominente la Altiplanicie Mexicana que es una serie de mesetas formadas entre las dos Sierras Madres, Oriental y Occidental. Estas Sierras unidas en la región ístmica de Tehuantepec van abriéndose a medida que avanzan sensiblemente de Sureste a Noroeste primero, y casi de Sur a Norte después. Esta altiplanicie de alturas variables cuya altitud va sensiblemente descendiendo hacia el Norte constituye una verdadera unidad geográfica de caracteres precisos. Dentro de una región propiamente tropical por su latitud, encontramos mesetas tan elevadas como los Valles de México y Toluca con altitudes de 2,200 a 2,500 metros sobre el nivel del mar (7,300 a 8,300 pies). Las altas cordilleras van descendiendo en múltiples serranías y estribaciones hacia los dos océanos que bañan el país, determinando ésto climas muy variados por la influencia de las lluvias y las diferentes altitudes, hasta llegar a los terrenos ligeramente pendientes de las costas que desaparecen en algunos puntos de los litorales por acercarse las montañas hasta la costa o bien forman pantanos y esteros muy prolongados.

[18] As vol. 15 of Die Vegetation der Erde.
[19] Author of many papers from 1866 to 1895, as well as contributor of observations to the comprehensive works of his brother, HERMANN MÜLLER.

[20] As vol. 8, issued in 1907.

La configuración de territorio determina cuatro divisiones fundamentales: la parte Continental propiamente dicha, la Zona Istmica de Tehuantepec, la región Peninsular que incluye las Penínsulas de Yucatán y la Baja California y la región Insular que comprende las islas pertenecientes a México en el Océano Pacífico.

La configuración y topografía del territorio determinan condiciones de humedad muy variadas, desde el clima muy húmedo de las estribaciones hacia el mar, en el Sureste, en donde se tienen lluvias prácticamente durante todo el año, hasta las mesetas interiores de la región norte de precipitación escasa y en algunos lugares casi nula. Esto sugiere que habrá condiciones muy diversas para la agricultura y para el desarrollo de la vegetación en general, encontrándose una tendencia favorable a producirse climas de acentuada aridez. Apenas si el 2%, en superficie, del territorio Mexicano, recibe lluvias normales durante 150 días; el resto del país es fundamentalmente seco. De la superficie total de cerca de 2,000,000 de Kmts.$^2$ apenas si en el 0.11% llueve más de 180 días, en el 1 a 2% llueve de 150 a 180, en el 4 a 6% llueve de 121 a 150 días, en el 13% llueve de 91 a 120 días, en el 28% llueve de 60 a 90 días; en el 38%, la más fuerte proporción y que representa 751,-000 Kmts.$^2$ de superficie, apenas si llueve de 31 a 60 días durante todo el año y todavía se tiene un 15% que representa 291,000 Kmts.$^2$ en donde llueve menos de 30 días durante el año. Las regiones de lluvias más abundantes se encuentran dispersas en superficies muy pequeñas en el centro de la Vertiente Oriental y en el Sureste. La enorme región seca abarca principalmente la altiplanicie que se extiende sin interrupción desde los Valles de México y Toluca hasta las fronteras con Estados Unidos. Esta región, en la que tiene que desarrollarse la más grande actividad agrícola, sostiene su agricultura penosamente, ya que no se cuenta con humedad proporcionada por la lluvia para sostener el crecimiento de las plantas de manera eficiente, pues aparte de su escasez, los regímenes pluviométricos de México se caracterizan porque las lluvias ocurren en un período de tiempo muy breve; dicho período es irregular, su intensidad es muy variable y las precipitaciones caen con extrema violencia, lo cual determina problemas de suma gravedad para la agricultura y coloca a México en condiciones de las peores que existen en el mundo. Debido a ésto gran parte de la superficie cultivada, que representa por lo menos *una tercera parte del total de superficie anual, deja de cosecharse porque faltaron las lluvias.*

Las tierras agrícolas de México están casi todas situadas en terrenos de fuerte pendiente o en valles angostos entre las montañas, lo que determina un efecto pavoroso de la erosión y consecuentemente el problema de la conservación del suelo alcanza proporciones que las condiciones económicas del país apenas si permiten controlar. Las tierras agrícolas de México, erosionadas y lavadas, tienen que producir muy bajos rendimientos y traen aparejada la lucha constante contra el hambre. Los suelos de México son consecuentemente muy variados. En la altiplanicie se encuentran suelos de color castaño (Chestnut), negros (Chernozem), que abarcan la mayor parte del centro del país y hacia el Norte hasta Sonora, llegando hacia el Sur hasta Oaxaca y la meseta de Chiapas; éstos, y los suelos de pradera (Prairie), que abarcan tambien una parte de la costa Norte del Golfo y la costa Sur del Pacífico constituyen los terrenos de cultivo más importantes y en donde la vegetación es prominente. También desde la altiplanicie hacia el Norte, incluyendo Baja California y parte de la costa de Sonora hasta la frontera con Estados Unidos, se encuentra una amplia provincia de tierras desérticas (Sierozem) y (Desert), pobladas por Crassicauletums y Sufruticetums con algunas pequeñas regiones incluídas de Graminoidetums. Estas tierras se encuentran también en el centro y Sur del país en una Zona de Puebla y Oaxaca. Las tierras rojas y amarillas, algunas de ellas lateríticas, se encuentran a lo largo de la costa del Golfo perteneciente a Veracruz, incluyendo el Norte de Oaxaca y el Norte de Chiapas. Son tierras que se cultivan con buenos rendimientos y en las que crece una muy variada vegetación tropical que va desde los Graminoidetums en forma de Sabana y los Arboretums de especies tropicales que se extienden en la costa de Veracruz, Norte de Oaxaca y Chiapas, Tabasco, Campeche y Quintana Roo. Pequeñas regiones dispersas en el centro y en el Norte se pueden considerar como Podsólicas y los suelos estudiados se completan con las zonas de Rendzinas que se encuentran en una región de la costa del Golfo entre Tamaulipas y Veracruz y en la región Sur y Oriental de Yucatán, Campeche y Quintana Roo, encontrándose tierra rosa (Terra Rossa), en la parte Norte de Yucatán y Campeche. Finalmente en la región Sur de la costa del Golfo de México se considera que existen suelos del grupo Gley, en las regiones bajas o inundadas de Tabasco. Naturalmente dentro de estas tierras los suelos van diferenciándose a medida que se sube en las cordilleras, determinando una abundante cantidad de tipos y alimentando muy variadas poblaciones vegetales que van desde la sabana y el bosque o selva tropical, hasta la vegetación arbórea Subalpina, así como propiamente Alpina de las crestas más elevadas.

Con tal variedad de climas México cuenta en su flora con una enorme cantidad de especies, desde las Xerófitas *Cactáceas, Amarilidáceas, Euforbiáceas*, etc., de las tierras desérticas hasta las especies de clima tropical húmedo, muchas de las cuales son apenas conocidas, a pesar de los estudios y colecciones formados.

Para dar una idea de las especies cultivadas y de la importancia de los cultivos que se realizan en México haré a continuación una reseña:

El maíz se cultiva en casi toda la República. Donde quiera que hay una pequeña aldea, se la encontrará siempre rodeada de campos de maíz, aún en las condiciones de aridez e infertilidad más extremas. El promedio de superficie sembrada en los últimos cinco años es de 3,238,844 hectáreas, con un bajísimo rendimiento medio de 560 kilos por hectárea, lo que se explica, tanto por las condiciones desfavorables de suelo y clima, principalmente por la falta de lluvia en el período vegetativo, como también por el estado de relativo atraso de los métodos de cultivo que se siguen en algunas regiones. Se cultivan un gran número de variedades de maíz profusamente distribuídas en todos los climas y adaptadas a condiciones de la más variadas. Esta adaptación a tan diversos climas, desde el clima muy frío y seco de la alta meseta y las estribaciones de las cordilleras, hasta el muy caliente y húmedo de las costas del Pacífico y

del Golfo de México, ha sido realizada en su totalidad por el cultivo contínuo a que han sujetado a esta planta nuestros grupos indígenas, más que por estudios científicos, pues sólo hasta hace tres años se han iniciado trabajos serios para el estudio genético del maiz, de adaptación, y de obtención de variedades. Las seis subespecies botánicas Eberta, Indurata, Indentata, Tunicata, Amylacea y Amylea-Saccharata se cultivan en diferentes variedades y también se las encuentra entremezcladas en híbridos espontáneos sobre todo entre Eberta e Indurata y entre Indurata y Amylacea. Las formas Eberta tienen el nombre de maíz "Palomita," las formas Indurata no tienen denominación especial excepto por los nombres de algunas localidades. Las formas de Indentata son llamadas maíz "Pepitilla" y las formas de Amylacea, cultivadas restringidamente, se denominan en general maiz "Cacahuazintle."

Las formas más ampliamente cultivadas y que en su mayor parte se utilizan para la alimentación del pueblo mexicano en forma de tortillas y tamales (especie de pan), y atoles (especie de pudines), provienen de las especies Zea Indentata, Indurata y Eberta, aún cuando las formas puras de esta última se utilizan principalmente para hacer las palomitas, "Pop Corn."

El trigo, que sigue al maíz en importancia, se siembra en una superficie media de 539,874 hectáreas, con un rendimiento promedio en los últimos cinco años de 628 kilos por hectárea, que es muy bajo. Aún cuando existen regiones en las que indudablemente se obtiene un rendimiento mayor, ocupan superficies muy reducidas. La mayor parte del trigo que se produce en México proviene de las regiones templadas y frías del centro del país y de algunas regiones irrigadas o que aprovechan las avenidas de los ríos en la región Norte, como La Laguna, los Valles de los ríos "Yaqui" y "Mayo," el Valle de Juárez ya en la frontera con Estados Unidos del Norte, etc. y en los Estados de México, Puebla, Hidalgo, Querétaro, Guanajuato, Michoacán y Jalisco. El trigo se cultiva en los calveros de los bosques en las tierras altas, llegando casi a 3,000 metros de altura sobre el nivel del mar; en las vegas angostas de los ríos, y en algunas planicies ligeramente onduladas pertenecientes a la "Mesa Central," irrigadas en su mayor parte por medio de obras que ha realizado la Comisión Nacional de Irrigación y en muy pequeña proporción la iniciativa privada. La mayor proporción de formas cultivadas de trigo en México, pertenecen a la especie *Triticum vulgare* y son las que se utilizan principalmente para harina de pan. También se cultivan en algunos lugares formas de *Triticum durum* y algunas variedades híbridas interespecíficas. Sólo en las estaciones experimentales para el trigo se encuentran en ocasiones poblaciones de *Triticum turgidum* y *T. polonicum*. Debido al intenso ataque de las *Puccinias* que en México se denominan communmente Chahuixtles, la Secretaría de Agricultura y Fomento, con la colaboración de especialistas Norteamericanos, principalmente de la Universidad de Minnesota, ha iniciado experimentos tendientes a obtener razas de trigo inmunes a esos hongos, con muy halagüeños resultados.

El frijol se cultiva también en todos los climas; pero principalmente en las tierras templadas y calientes. El promedio de superficie sembrada en el último período de cinco años, es de 616,653 hectáreas, con un rendimiento promedio de 1990 kilos por hectárea. Las especies de frijol cultivadas más generalmente en México pertenecen a las tres especies *Phaseolus vulgaris*, *P. multiflorus* y *P. lunatus*. Las formas del *vulgaris* son principalmente cultivadas en las regiones frías y templadas y cubren la mayoría de la superficie anotada. Sus formas son muy variadas y se utilizan tanto las vainas tiernas (ejotes), como las semillas secas, que constituyen en México entre los campesinos el platillo fundamental en la dieta, siendo las tortillas de maiz, el pan, y el condimento obligado, el chile (*Capsicum*). La especie *multiflorus* se cultiva de preferencia en las regiones frías de la "Mesa Central" y sus formas blanca y de color rosado se denominan "ayocotes." En las regiones cálidas se cultivan algunas formas de *lunatus*, también usado para la alimentación; pero de más difícil cocimiento y baja calidad. Entre estos frijoles se encuentra a veces el *Ph. aconitifolius* var. *latifolius*, al que en el Sureste llaman "escumite" y es el Tepary en Norte América. También se le cultiva en algunas regiones del Norte (Sonora, etc.). Se cultivan en muy reducida escala *Vigna sinensis* y *Soya max*. En las regiones frías de la alta meseta se cultivan en escala regular el Haba (*Vicia faba*), asi como el Chícharo (*Pisum*), y en las templadas el Garbanzo (*Cicer*). Es también muy importante objeto de cultivo el Cacahuate o maní (*Arachis hypogaea*), en todas las zonas templadas y calientes.

En tierra caliente puede encontrarse sub-espontáneo el "Pidgeon pea" (*Cajanus indicus*), tan valioso en la India Inglesa como forraje y alimento del hombre. En la región templada del centro del País, en las tierras arcillosas compactas de riego que se encuentran en la Zona denominada "Bajío," se cultiva la lenteja (*Lens esculenta*), en una superficie importante.

El arroz sigue al frijol en importancia; se siembran alrededor de 47,509 hectáreas, con un promedio de rendimiento en arroz palay de 1,992 kilos por hectárea.

El arroz se cultiva en todas la regiones calientes y en algunas regiones templadas del Norte del País. Los más altos rendimientos se obtienen en donde se cultiva con riego permanente siguiendo el sistema de trasplante que se asemeja al método chino y de la Malasia. Estos arroces, de la Subesp. *utilissima*, forma *communis*, que son los de mejor calidad, se utilizan preferentemente para sopas. Morelos y Puebla se destacan principalmente en la producción de arroz de riego. En otras regiones de clima cálido el arroz se cultiva en las lomas, y en terrenos montañosos de poca altura sin riego, obteniéndose productos de muy buena calidad, pero con bajos rendimientos. Finalmente en las regiones templadas irrigadas del Norte también se cultiva arroz, principalmente alrededor de Cajeme, en el Estado de Sonora: estos arroces son generalmente de variedades Americanas, como la Edith y la Blue Rose; algunas pertenecientes a la Subesp. *glutinosa*, son de inferior calidad y se utilizan para budines, repostería y para la fabricación de cervezas.

Sigue en importancia el algodón, del que se cultivan 285,615 hectáreas en promedio de los últimos cinco años, con un rendimiento medio de 248 kilos de algodón pluma por hectárea, lo que representa una producción anual de 307,622 pacas de 230 kilos. Casi no hay región templada o caliente en donde no se encuentre algodón creciendo cultivado o espon-

táneo; sin embargo, las regiones en donde se cultiva esta planta están perfectamente definidas; la región principal se encuentra entre los Estados de Coahuila, Nuevo León y Durango y comprende la región "Lagunera" cuyo centro es la ciudad de Torreón; la otra región importante está localizada en el Golfo de México, limítrofe con Estados Unidos, y se extiende alrededor de la ciudad de Matamoros, en el Estado de Tamaulipas. Por otra parte en el extremo Noroeste de la Península de California, también en región limítrofe con Estados Unidos, se encuentra la Zona de Mexicali en la que se produce el algodón de más alta calidad. Las formas cultivadas en general pertenecen a especies de las regiones tropicales y sub-tropicales de este Continente, así como de las islas de las Indias Occidentales, fundamentalmente *Gossypium hirsutum, G. barbadense* y *G. mexicanum* o híbridos entre estas especies. Como antes se dijo, en las regiones del Sureste las gentes cultivan en los patios o pequeños terrenos, sobre todo en las comunidades indígenas, formas que pudieran pertenecer a las especies *G. fruticulosum* y *G. lanceolatum.* Aún cuando el algodón es planta importante de cultivo en México y el material para trabajos genéticos es abundante y variado dentro de las propias especies Mexicanas, fuera de las extensas colecciones hechas por los Americanos y por VAVILOV, aún no se estudian en nuestro país las posibilidades de producir variedades y solamente se han hecho selecciones y estudios de adaptación de variedades cultivadas en Estados Unidos.

La caña de azúcar ocupa un lugar importante con 96,426 hectáreas de promedio, con un rendimiento medio de 48.5 toneladas por hectárea.

La caña de azúcar se cultiva en condiciones climatéricas muy variadas, pues se le cultiva tanto en regiones del Pacífico Norte y del Golfo, más allá del Trópico de Cáncer, en el Estado de Sinaloa y en el de Tamaulipas, como en el Pacífico Sur, en los Estados de Nayarit, Jalisco, Colima, Michoacán, Guerrero, Oaxaca y Chiapas. De la misma manera que en el Golfo, al Sur del Trópico de Cáncer, se cultiva en el Estado de Veracruz, y en menor proporción en Tabasco y Yucatán. Cultívase también en el centro del País en los Estados de Morelos, Puebla, Hidalgo, San Luis Potosí y Guanajuato. Los climas varían desde el templado cálido, con lluvias más o menos abundantes durante 4 o 6 meses y los cálidos y húmedos, con lluvia abundante, durante 6 meses o más. En algunas regiones como las de Morelos y Puebla, la caña se cultiva bajo irrigación. En otros lugares se mantiene exclusivamente con la lluvia y las brisas húmedas.

Los terrenos en que se cultiva la caña en México son por lo general arcillosos compactos, de pradera como los de Morelos, de color negro o café y de color rojo café en las costas. Las cañas se cultivan en las regiones del Sureste en tierras más francas, generalmente migajones limo-arenosos con arenas micáceas. En Tabasco se cultiva también en terrenos de acarreo, un poco más arcillosos y lexiviados. Aún se cultivan en vasta proporción las viejas cañas criollas: cristalina, veteada y morada. Sin embargo, las variedades mejoradas de Java, la India y Hawaii, se están destacando definidamente. Las más cultivadas son: — P.O.J. 2878. — P.O.J. 2725. — P.O.J. 36. — C.O. 281. — C.O. 290. — C.O. 210. — H. 109, etc. La Secretaría de Agricultura y Fomento cuenta en "Zacatepec" y "El Potrero," con Campos Experimentales, en los que se tienen muy buenas colecciones, incluyendo las especies salvajes.

Las plantas forrajeras más cultivadas en México son: — la cebada y la avena, que se cultivan en las tierras frías de la altiplanicie o en las relativamente bajas de la región Norte como en los Estados de Chihuahua y Coahuila. Ya se cultivan también variedades de avena utilizables para la alimentación humana. La cebada fundamentalmente se utiliza para la alimentación del ganado caballar y de los cerdos. También se cultivan en las tierras ligeramente templadas y calientes diferentes variedades de Sorgos (*Andropogon*); en las praderas naturales como subespontáneas y en las artificiales, crecen diferentes gramináceas o zacates, sobre todo en las regiones más calientes en donde se cultivan zacate gordura (*Melinis minutiflora*), zacate guineo (*Panicum maximum*), zacate Pará (*Panicum barbinode*), zacate Johnson, que en algunas regiones del Norte del País ya constituye una verdadera plaga para la Agricultura. En las regiones secas se utilizan como forrajeras para el ganado los cladodios de *Opuntias* sin espinas como la especie inermis, de la misma manera que las bases de las pencas tiernas de magueyes, (especies de *Agave*). En la Altiplanicie y siempre bajo irrigación, se cultiva la alfalfa para alimento del ganado y sólo como excepción, en algunas regiones pequeñas del Valle de Oaxaca se desarrolla la alfalfa sin riego gracias a que el agua del sub-suelo abastece de humedad a las raíces por encontrarse a profundidad conveniente. Los establos de la ciudad de México y de las ciudades más importantes de la Altiplanicie consumen fundamentalmente alfalfa verde o achicalada. Algunas otras leguminosas como la Veza (*Vicia sativa*), el frijol soya, tréboles de diferentes especies, el chícharo de vaca, etc., se usan como forrajeras en las diferentes regiones del país.

Todas las frutas europeas, casi sin excepción, incluyendo las *Pomáceas* como duraznos, manzanas, peras, ciruelas, cerezas, etc., se cultivan en México, a las que se agregan en las tierras frías los espontáneos y cultivados capulines (*Prunus capulli*); además como espontaneos de México de la tierra fría, los tejocotes (*Crataegus* Sp.). En las tierras templadas se encuentran cultivadas las uvas. Cuenta México con regiones vinícolas bastante determinadas aunque todavía no suficientemente desarrolladas. Se cultivan también en las huertas de clima templado higos, plantas cítricas entre las que se destaca muy especialmente la naranja Bahía, sin semilla. En la tierra caliente se encuentran diferentes *Anonáceas:* chirimoyas, guanábanas, papauses, etc. Tanto en las tierras templadas como en las calientes se encuentran las diferentes especies del género *Persea* (*P. gratissima, P. drimifolia,* etc.), cuyos frutos son los ahuacates y pahuas llamados paltas en algunos lugares de Sudamérica. Papayos, ciruelos de tierra caliente (*Spondias lutea,* etc.). Los zapotes, nombre que se dá a frutos de *Diospyros* Sp. y de *Casimiroa,* que son magníficas frutas y que respectivamente se llaman zapote prieto y zapote blanco. El mamey, nombre que se dá a frutos de los géneros *Lucuma* y *Calocarpum,* así como *Mammea.* Una fruta muy característica de México, cuyos árboles semejan al árbol de Baobab (*Adansonia*), es una *Caricácea* llamada *Jacaratia mexicana,* conocida por Bonete. Las especies más impor-

tantes del género *Musa*, los bananos y plátanos, incluyendo el Roatán, que es el exportado en grandes cantidades por México a Estados Unidos, se cultivan ampliamente en el país.

Casi todas las especies de frutas tropicales de este Continente se encuentran representadas entre las cultivadas en México.

Entre las plantas industriales, aparte del algodón, se tiene el muy importante Henequén (*Agave sisalana*), que se cultiva muy ampliamente en la Península de Yucatán. Otras especies de *Agave* y *Furcraea*, y también algunas *Bromeliáceas*, así como el Yute, proporcionan fibras para las industrias y para la exportación. Para terminar, diré que en la actualidad todos los cultivos se están intensificando a pasos acelerados con el deseo unánime de hacer frente a la economía de guerra y de que México colabore con las demás Naciones en el esfuerzo que se está desarrollando por la libertad. Uno de los ejemplos de este esfuerzo es el establecimiento de una Estación Experimental y Plantaciones de Quinas (*Cinchona*), por Dependencias del Gobierno Federal, así como la existencia de viveros de hule (*Hevea*) y la iniciación de los cultivos de muy diferentes plantas industriales y medicinales.

Numerosas plantas se cultivan en México para la producción de aceites, encontrándose muy extendido el cultivo del Ajonjolí (*Sesamum indicum*), la Higuerilla (*Ricinus communis*), y el Cocotero. Con el objeto de hacer frente a la escasez de grasas y aceites se están incrementando el cultivo del Girasol (*Helianthus*) y del Tung (*Aleurites*); la explotación intensa del Coquito de aceite o corozo (Especies de *Orbigna, Attalea*, etc.). La palma de aceite (*Elaeis guineensis*), constituirá en el futuro un objeto de cultivo, pues México cuenta con extensas regiones adaptables para esa planta. En la Flora Mexicana hay especies oleaginosas de porvenir que no se han estudiado debidamente.

México podrá aportar un valioso contingente en el futuro a la economía del Continente, al utilizar sus variados climas y suelos, para producir casi la totalidad de las especies económicas de plantas que se cultivan en el mundo.

PLANTACIONES DE QUINA,
DEPARTAMENTO DE SALUBRIDAD PÚBLICA,
CACAHOATAN, CHIAPAS, MÉXICO.

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E. C. STAKMAN and J. G. HARRAR: **Plant Pathology in Mexico**:—Despite its extensive resources in minerals and petroleum, Mexico is essentially an agricultural country. Because of geographic location and topography there are extremes of ecologic conditions; and a wide variety of plants are grown, ranging from temperate zone plants to those of the tropics.

Mexico produces an almost bewildering array of economic plants. Corn is king, with more than 50 per cent of the crop land devoted to it. Wheat, beans, cotton, barley, and sugar cane follow in about that order. Other important crop plants are rice, potatoes, tomatoes, chili peppers, peanuts, citrus fruits, apples, coffee, cacao, bananas, papaya, vanilla, castor beans, alfalfa, tobacco, henequen and a considerable variety of minor crops.

Not only is there great diversity in kinds of crops grown but there often is equally great diversity within certain crops themselves. Until recently, relatively little has been done to select and standardize varieties scientifically; consequently there sometimes are many varieties and mixtures of varieties. There are, for example, many types of corn (maize), with many degrees of localization in distribution. Likewise, there are many varieties of wheat, sometimes a dozen in a single field; and it is said that as many as 250 varieties of beans are grown. This situation results partly from natural selection and subsequent conscious selection of those varieties best adapted to each of the very varied soil and climatic conditions. Insofar as this is true, productivity is increased. But it is evident that some varieties are grown under unfavorable conditions; in either case the complexity of disease problems is increased also.

There can scarcely be anything even approaching uniformity in the disease problem in many of the important crop plants because numerous varieties often are grown under so wide a range of environmental conditions. Corn is grown from the humid subtropics, sometimes interplanted with pineapples or bananas, to the semiarid high plateaus, mountain valleys, and steep mountain sides: from near sea level to an elevation of almost 9000 feet, with extreme differences in soil conditions, rainfall, and temperature. Wheat and beans are grown under a similarly wide range of conditions. Accordingly, time of planting, length of growing period, and time of maturity may differ greatly within a small area; and the differences in the country as a whole are very wide. There is, therefore, extreme regional and seasonal variation in disease development; hence a detailed descriptive account of the disease situations would require far more particularization than is possible at present, both because of lack of space and lack of adequate information. For most diseases, broad generalizations only are possible.

Plant diseases in Mexico can conveniently be placed in three broad categories: Those that are debilitating but not conspicuous; those that cause considerable obvious losses more or less regularly; and those that may cause devastating epidemics.

Debilitating but inconspicuous diseases have hitherto received relatively little attention in Mexico. This is not surprising because the etiology of many such diseases is obscure; consequently extensive observations and investigations are necessary in elucidating their nature. Affected plants often merely appear unthrifty, and predisposing factors easily may be mistaken for the direct cause. Nowhere has this class of diseases been investigated sufficiently, but in many respects there is special need in Mexico, because of the tendency toward monoculture in some areas, the lack of adequate soil management on many farms, and the fact that crop varieties are often grown outside their optimum ecologic range. Among such diseases are root rots of corn and of small grains; they occur in Mexico and sometimes cause considerable dam-

age, but information regarding their prevalence and destructiveness is entirely inadequate. From experience in the United States and elsewhere, it is likely that losses in Mexico can be reduced by a combination of seed treatment and appropriate cultural practices designed to promote the growth of sturdy plants that either resist the causal organisms (*Helminthosporium* spp., *Alternaria* spp., *Fusarium* spp., and others) or tolerate their effects. Nevertheless, experimentation under the various conditions that prevail in Mexico is required before specific recommendations for control can be made.

Diseases of the second category include corn smut, corn rust, ear rots of corn, smuts of wheat and barley, wilts of tomato and chili peppers, potato scab, late blight of potato, certain fruit diseases such as scab, bitter rot, and fireblight of apples, and numerous leaf-spot diseases of a variety of plants. Chemical control measures for some of these diseases are well known and easily applied; others require special treatment; and some, such as corn smut and the wilts, must be held in check principally by the use of resistant varieties. Corn smut is so generally eaten as human food that it appears to be an asset rather than a liability in many native corn fields. Loose smut and stinking smut of wheat are widespread and sometimes so abundant as to be of major importance. This is true also of the loose and covered smuts of barley. The modified hot water treatment for controlling the loose smuts is scarcely used at all, but surface disinfection of wheat and barley for the control of stinking smut and covered smut, respectively, is practiced to some extent, varying with the locality and kind of farmer. At some of the agricultural schools there are public-service seed-treating machines for free treatment of farmers' seed. So far, however, relatively few have availed themselves of this service. There is rather general appreciation among growers, certainly the more advanced ones, of the need for disease-resistant varieties, and some growers use such varieties as are available. In general, however, there is a considerable need for more widespread use of control measures already available.

Of the epidemic diseases, chamusco or sigatoka (*Cercospora musae*) of bananas probably has been the most spectacular during the past few years. It appeared about 1937 and soon made commercial production of bananas unprofitable in some of the principal banana-growing districts and menaced the entire industry. The disease is now controlled, however, in the best plantations by proper spraying with bordeaux mixture. Many plantations have thus been rehabilitated and are again profitable productive enterprises.

The most typically epidemic diseases of crop plants are, however, the rusts of wheat. Orange leaf rust (*Puccinia rubigo-vera tritici*), yellow stripe rust (*P. glumarum*) and stemrust (*P. graminis*) are generally distributed, but the destructiveness of each varies greatly with the region and the season. Most of the varieties commonly grown are susceptible to all three rusts; consequently they can propagate and spread rapidly under favorable weather conditions. Moreover, some wheat is grown throughout the year. Although most of it is grown as a winter crop, some is grown in the summer also. Even where there is no summer crop, there are likely to be some volunteer plants on irrigated land, and the rusts may therefore survive in the uredial stage throughout the year in enough places and in sufficient quantity to become locally or regionally epidemic whenever weather conditions favor rust development for sufficient periods of time. Nevertheless, avoidance of out-of-season sowings of wheat would help measurably in reducing rust losses.

Stem rust is not only the most destructive disease of wheat in Mexico but is considered by informed Mexican agriculturists as one of the important problems in crop production. Not only does it sometimes cause devastating epidemics but it also limits the areas in which wheat can be grown profitably. As the Mexican Government desires an expansion of wheat growing, control of stem rust is their most pressing plant disease problem. And its importance is not limited to Mexico alone.

Actually, the control of stem rust of wheat in Mexico is almost as important to the United States and Canada as to Mexico herself. It is in reality an international problem. The general features of stem rust development in Mexico are known as a result of long-time studies made cooperatively by the Mexican and United States Departments of Agriculture. It is known that there may be a seasonal interchange of rust between the two countries: Rust from the United States may be blown into northern Mexico in the fall and rust from northern Mexico may be blown into the United States in the late winter and early spring.

For purposes of understanding rust epidemiology, there are three general wheat-growing regions in Mexico: The Southern, the Northern, and the Northwestern. The Southern region lies roughly south of San Luis Potosi; and includes discrete areas or localities from the states of Puebla and Oaxaca on the east to Jalisco on the west. It includes the rich Bahio region and the Valley of Mexico. The Northern region is principally in the states of Tamulipas, Nuevo Leon, and Coahuila, but there is some wheat in Durango and Chihuahua also. The Northwestern region is principally in the state of Sonora.

Conditions are by no means uniform within these general regions. The southern and northern regions, particularly, comprise areas of greater or less extent that are separated from each other by mountain ranges or other natural barriers; consequently the factors affecting rust development may differ greatly in these different areas, even in the same season. Epidemics are therefore likely to be more localized than is true of the Mississippi Valley of the United States. Nevertheless, certain general facts are known about each of the larger regions.

So far as now known, rust conditions in the southern wheat-growing region of Mexico are peculiar to that region. Studies made by the United States Department of Agriculture in cooperation with the Mexican Department for a number of years indicate that there is relatively little annual interchange of rust between Southern Mexico and Northern Mexico. The physiologic races of *Puccinia graminis tritici* in Southern Mexico have been quite uniform for at least the past 12 years. Indeed, there is even considerable localization in their distribution within the region. Only three have been found commonly—races 19, 38, and 59, of which the last two are the most prevalent. There have

been indications recently, however, that race 56, by far the most prevalent and generally distributed race in the United States during most of the period from 1934 to the present time, may now be establishing itself in Southern Mexico. If so, the situation with respect to resistant varieties will change. Heretofore, Marquis wheat, one of the most susceptible in the Mississippi Valley of the United States and in certain areas of Northern Mexico, has been quite resistant in Southern Mexico because of its resistance to races 19, 38, and 59, which constituted well over 90 per cent of the inoculum in that region. It appears now that the problem of introducing or selecting resistant varieties for Southern Mexico should be relatively simple as compared with that in Northern and Northwestern Mexico.

The physiologic races of *P. graminis tritici* in Northern Mexico are essentially the same as those in the United States, and there has been a tendency for their seasonal prevalence to vary together. This is because of the demonstrated fact that spores are sometimes blown from the United States into Northern Mexico in the fall and the rust may thus become established on early-sown winter wheat, on which it may then overwinter and produce varying amounts of rust in the following spring. Some of the wheat-growing areas, notably those near Torreon, Saltillo, and Sabinas Hidalgo, are only a short distance from wheat-growing areas in the United States, with no natural barriers intervening. Therefore rust sometimes is blown at least from the latter two areas into Texas and possibly other states in the late winter or early spring. In reality, therefore, Northern or Northeastern areas of Mexico are extremely important in some seasons in the development of rust in the United States. Heavy epidemics sometimes develop in certain areas of Northern Mexico, losses sometimes amounting to as much as 60 per cent of the crop. This is not only a calamity for Mexican growers but the large amount of inoculum is also a menace to wheat in the United States, as it has been shown that wind can blow urediospores hundreds of miles northward within a day or two. The problem of producing resistant varieties for Northern Mexico is therefore quite similar to that in the United States and is important for both countries. In general, the rust-resistant spring wheats developed within the past 15 or 20 years in the United States are resistant in Northern Mexico also. There still remains the problem, however, of selecting those best adapted to Mexican conditions.

Less is known about factors affecting rust development in Northwestern Mexico, where destructive epidemics sometimes develop, than in the other two general wheat-growing regions. It is known, however, that there are considerable numbers of physiologic races of *P. graminis tritici* in this area and that certain varieties have been resistant in that region for a number of years, only to become susceptible, presumably because of changes in the prevalence of physiologic races.

The Mexican Department of Agriculture, in coöperation with the United States Department of Agriculture, the Rockefeller Foundation, and the Rust Prevention Association of Minneapolis, Minnesota, is now making extensive varietal tests of wheat in well-selected localities in each of the major wheat-growing regions. As a result of this work, it seems possible that resistant varieties can be selected from among those already available, even though different varieties probably will have to be selected for different regions or possibly even for areas within regions. Prospects are, however, that fairly rapid progress can be made.

The work on stem rust of wheat is merely one example of the extensive scale on which certain plant-disease problems are now being attacked in Mexico. This particular problem is essentially one of selecting or breeding resistant varieties, and the knowledge of the intricacies of the disease situation is being used as a basis for procedures.

Although attention has been focussed on the wheat stem rust problem in Mexico, general crop improvement work of the Mexican Department of Agriculture is contributing incidentally to the control of other diseases also. As an example, a corn improvement program has been in progress for several years, and breeding work with other crops also has been begun. As the primary objective in these breeding programs is improvement of yield and quality, those lines with a certain amount of disease resistance will be selected on the basis of their performance. This will alleviate certain disease problems to a considerable extent.

*Organization.* — Plant Pathological activities in Mexico are primarily a function of the Secretary of Agriculture, which is comparable in organization with the United States Department of Agriculture. Within the Secretaría, one of the major divisions is the Dirección General de Agricultura, corresponding to the Bureau of Plant Industry of the United States Department of Agriculture. The Dirección is subdivided into a number of divisions, one of which, the Departamento Fitosanitario, has the responsibility of organization, research, extension, and regulatory work in the fields of plant pathology and entomology. The administration of this organization is centered at San Jacinto in México, D.F., where a number of administrative and technical experts are stationed and where all experimental activities originate.

Distributed throughout the country are some 30 Delegaciones Fitosanitarias, which are offices in control of the pathological and entomological programs of the respective states. Depending from the Delegaciones are one or more Jefaturas de Zona, with responsibility for the work in specified zones. The duties of the Delegaciones and Jefaturas include quarantine and other activities connected with the movement of plant products, dissemination of information to growers and coöperatives (ejidos), collection of information for the federal office, and coöperation with the experimental farms (campos experimentales).

There are 14 experimental farms in the Republic, mostly located strategically with respect to one or more important crops in given areas, *i.e.* sugar cane, henequen, corn, wheat and cotton. Although the experimental farms are an administrative unit of the Dirección General de Agricultura and are distinct from the Delegaciones Fitosanitarias, close coöperation is maintained between the two.

*Education.* — Most of the instruction in phytopathology is given at the National College of Agriculture at Chapingo, near Mexico City. This institution is a dependency of the Secre-

taría de Agricultura and maintains close association with its activities, including those of the Dirección de Agricultura. Phytopathology is included with Entomology in the curriculum, and a certain number of students major in this combination each year. The complete course, including preparatory, requires seven years, and graduates are almost entirely absorbed by the Secretaría de Agricultura.

A state agricultural college is located at Saltillo in the State of Coahuila. This institution rather restricts its training to the general field of agriculture and the graduates in plant science are characteristically agronomists. A similar situation exists at the private agricultural college in Ciudad Juarez in the State of Chihuahua. Graduates of both institutions are eligible for employ by the Department of Agriculture.

The Instituto Politécnico, in Mexico City, is a dependency of the Secretaría de Educación and offers work at the college level in all fields of biological science and recently has begun to give some training in the field of applied mycology and soil microbiology.

The Mexican Department of Agriculture is making progress in effecting an organization and educating men that will bring about improvement in plant pest control. In this, as well as in other agricultural projects, assistance now is being given by the Rockefeller Foundation, which established an agricultural project in Mexico during the past year.

UNIVERSITY FARM,
SAINT PAUL, MINN., *and*
THE ROCKEFELLER FOUNDATION,
MÉXICO, D. F.

T. G. YUNCKER: **The Vegetation of Honduras, a Brief Review:** — The vegetation of Honduras as a whole is very imperfectly known. With the exception of a few collections which have been made in the Atlantic coastal plain region and at scattered inland points, most of the country remains wholly unexplored in the botanical sense. Enough is known, however, to indicate a large flora rich in endemic species. About 500 species of trees have been listed for the country, a number which will doubtless be greatly increased by further exploration especially at the higher altitudes. The plants of the coastal plain are predominatingly those which one finds throughout Central America in similar situations from South America north to Mexico, and the forests of the interior contain many species common elsewhere in Central America.

Along the Caribbean and, to a limited extent, about the Gulf of Fonseca is a low, sometimes marshy, region which varies from a very narrow strip where the mountains occasionally reach the sea to several miles in width. This coastal plain reaches its greatest width in the Mosquitia Territory at the east. It also extends inland to some extent along the main river courses, especially those of the Ulua and the Aguan. Here extensive plantations of bananas are to be found which have necessitated the elimination of large areas of native vegetation. Along the shore, around brackish lagoons, and inland for some distance along sluggish streams occur mangrove swamps composed mostly of *Rhizophora Mangle*. On this low land are also found extensive swamps and marshes of shallow water and islands of vegetation made up of tall grasses and sedges together with various swamp species of *Sagittaria, Polygonum, Pontederia, Mimosa, Pistia, Jussiaea, Hibiscus, Thalia,* etc. In abandoned banana plantations and other similar cut-over areas a second-growth made up of a large variety of herbs, vines, shrubs and small trees quickly reclaim the land with a very dense entanglement.

Except for this low northern coastal plain the country is very rough and mountainous. From the plain the land may rise gradually in a series of foothills and plateau-like plains or the ascent may be rapid and abrupt. The highest mountains are to be found toward the Pacific side although a few peaks in the northern coastal range rise to about 2500 meters. The Caribbean coastal plain and mountain slopes receive an ample rainfall. The vegetation is abundant there and the mountain slopes are covered with a luxuriant forest.

Among the more common woody and conspicuous herbaceous genera which are to be seen on the plains and adjacent mountain slopes may be mentioned: *Anthurium, Philodendron, Tillandsia, Aechmea, Heliconia, Costus, Calathea, Pleiostachya, Piper, Salix, Trema, Cecropia, Ficus, Myriocarpa, Cissampelos, Siparuna, Compsoneura, Virola, Nectandra, Licania, Acacia, Calliandra, Inga, Mimosa, Pithecolobium, Enterolobium, Bauhinia, Dialium, Gliricidia, Lonchocarpus, Dalbergia, Machaerium, Guiarea, Swietenia, Trichilia, Byrsonima, Stigmaphyllon, Vochysia, Acalypha, Sapium, Spondias, Paullinia, Triumfetta, Pavonia, Ochroma, Quararibea, Conostegia, Cordia, Lantana, Cestrum, Solanum.* Ferns, including tree-like species, are abundant and in the forests epiphytic orchids and bromeliads are represented by many species. In the middle and upland forests occur many species of palms ranging in size from the miniature *Chamaedorea* to the giant *Orbigyna Cohune.*

In the interior many of the mountains are densely forested much as are those near the coast, especially towards their summits and in ravines where numerous species of trees, shrubs, ferns, orchids, arums, bromeliads, many woody and herbaceous vines, peperomias, etc. grow very rank. This is especially true of the mountain slopes and region about Lake Yojoa where the vegetation gives the impression of being wholly untouched by the hands of man and undoubtedly contains many interesting and unknown species.

In many parts of the interior the rainfall is less, and open park-like regions with pine and oak forests are predominant. This type of forest is also to be found on the leeward slopes of the northern coastal range. Such a region is found above Lake Yojoa about the village of Siguatepeque which is situated on a plain at 1100 meters. The plain, which is somewhat uneven and has occasional rocky outcroppings, is surrounded by mountains which rise to an altitude of 2000 meters or more. Rising from the plain is a range of more or less rocky foothills forested with a well-marked, parklike zone of *Pinus oocarpa* and *P. pseudostrobus* associated with broadleaf species, principally oaks. During the wet season the forest floor is carpeted with various species of flowering plants and short grasses. Above the pine-oak zone is found the more steeply rising ridges and gulches of the highest peaks covered for the most part with upland deciduous forest of many large and often buttressed trees.

In the Aguan river valley above Olanchito is a semi-arid region which ordinarily receives but 35 to 40 inches of rainfall annually. Characteris-

tic plants of this region include several species of cacti two of which become giant tree forms (*Opuntia hondurensis* and *Cereus Yunckeri*). Associated species in this region are *Zamia furfuracea, Smilax mollis, Piper* spp., *Celtis iguanaea, Coccoloba* spp., *Iresine nigra, Capparis* spp., *Acacia riparia, A. spadicigera, Pithecolobium dulce, Benthamantha mollis, Erythrina hondurensis, Bursera Simaruba, Acalypha* spp., *Croton flavens, Jatropha urens, Pedilanthus tithymaloides, Cupania glabra, Paullinia pinnata, Clusia flava, Hasseltia floribunda, Eugenia* spp., *Ardisia pascalis, Rauwolfia hirsuta, Psychotria* spp., *Eupatorium albicaule*. A similar dry area is also found about Comayagua in the interior.

The first attempt of any extent at a study of the Honduran flora was made by PAUL C. STANDLEY who spent several months during the winter of 1927/28 collecting in the Lancetilla Valley and the region about Tela on the northern coast. Professor S. J. RECORD also visited Honduras in 1927 and prepared a list of the trees of the country to which STANDLEY made additions in a second list published in 1930. The writer has made three collecting expeditions to the country. Several weeks were spent during the summer of 1934 collecting in the Lancetilla Valley region at Potrerillos and about Lake Yojoa in the department of Cortés. In 1936, accompanied by R. F. DAWSON and H. R. YOUSE, collections were made in the vicinity of Siguatepeque in the department of Comayagua and in 1938, assisted by JAMES KOEPPER and KENNETH WAGNER, several weeks were devoted to collecting around La Ceiba on the northern coast and in the Aguan River Valley near Coyoles in the department of Yoro.

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P. ANTON KOVAR: **Idea General de la Vegetación de El Salvador:** — El Salvador, la más pequeña república centroamericana (34000 km. cuadrados), no es prácticamente más que una estrecha faja de terreno, situada en la vertiente del Pacífico y comprendida entre Guatemala, Honduras y el Golfo de Fonseca.

Su clima está caracterizado por dos estaciones, una de lluvia, llamada por los naturales Invierno (Mayo-Octubre) y otra de sequía, conocida como Verano (Noviembre-Abril). La mayor parte de las lluvias, cuyo total asciende a unos 2000 mm. cae en los meses de lluvia; durante los demás meses las lluvias son escasas. Terminada la estación lluviosa, en los meses de Noviembre, Diciembre y Enero, fuertes vientos (llamados norte) pronto acaban con la humedad almacenada en el suelo.

El país, aunque muy quebrado, no presenta grandes elevaciones en general y en todo caso éstas ocupan porciones muy limitadas del territorio. En la frontera con Honduras penetran en el país ramificaciones de lo que algunos llaman la Cordillera. Una de éstas ramificaciones, la de los Esesmiles, alcanza la altura máxima de El Salvador con unos 2700 m. Más al sur, en la faja central, el país es recorrido por una cadena constituida por unos cuantos, más o menos aislados, picos volcánicos, de los cuales el más alto es el de Santa Ana que tiene unos 2360 m. Paralelamente a la costa, a veces muy junto a ella, y a veces un poco alejada, corre la llamada Cadena Costera, la cual principia en la parte oriental del departamento de Sonsonate, cruza los de La Libertad y de San Salvador para morir en el de La Paz, llegando a su altura máxima en la Cumbre (1100 m.), situada en el Departamento de La Libertad. Reaparece después en el departamento de San Miguel con el nombre de Colinas de Jucuarán y termina en el Golfo de Fonseca.

El Salvador aunque muy pequeño, es sin embargo la más poblada de las repúblicas centroamericanas. Su densa población es prevalentemente agrícola y este hecho unido a los sistemas agrícolas en uso ha conducido a la destrucción casi total de la vegetación primitiva.

De lo dicho, fácilmente se deduce que la flora de éste país no puede compararse ni en riqueza de especies ni en exuberancia con la de los demás paises centroamericanos.

En linea general se puede decir que la vegetación de El Salvador es la misma de las costas occidentales de México, Guatemala, Nicaragua, Costa Rica y Panamá, predominando marcadamente, como sucede en general en Centro América a todos los paises situados al norte de la depresión de río de San Juan, la influencia de Norteamérica tropical. El País casi no posee especies endémicas; el número de las plantas conocidas unicamente de El Salvador va disminuyendo rapidamente con el progreso de los estudios botánicos en los paises colindantes.

La mayor parte de El Salvador está situada en la *Zona Tropical Arida Inferior*. Esta se extiende desde la costa hacia el interior del país, subiendo por las pendientes de los volcanes y de las montañas hasta una altura que oscila entre 800 y 1000 metros. Hay muy poca vegetación original y la poca que queda va desapareciendo con ritmo acelerado. Hasta la altura de unos 500 m. hay grandes haciendas en las cuales, además del ganado y de los pastos consiguientes, hay campos de algodón, maíz, frijoles, caña de azúcar; de los 500 m. para arriba aparecen ya los primeros cafetales.

La vegetación original cambia según los distintos ambientes. En la costa, en lugares periodicamente invadidos por las aguas del mar se encuentran los manglares, formados por la asociación en proporciones variables de *Rhizophora mangle, Avicennia bicolor, A. nitida, Conocarpus erecta, Laguncularia racemosa,* principalmente en la Barra de Santiago, Esteros de Jaltepeque y de Jiquilisco y algunos puntos de la Bahía de Fonseca. En las arenas de las playas, generalmente no alcanzadas por las aguas del mar se pueden encontrar *Ipomoea pes-caprae, Hippomane mancinella, Heliotropium curassavicum, Pectis arenaria, Capparis flexuosa,* etc.

Dejadas las playas, principian las selvas decíduas. Su composición es variable y también el tamaño de los individuos, alcanzando formas gigantescas en los lugares bajos y pantanosos y disminuyendo después con la distancia de la costa; sin embargo al llegar al límite superior de ésta zona, hay cierto regreso, al menos en algunas especies, a las formas grandes. Las principales especies que aquí se pueden encontrar son: *Ficus* spp., *Enterolobium cyclocarpum, Cassia grandis, Hymenaea courbaril, Hura polyandra, Ceiba pentandra, Bombax ellipticum, Ster-*

*culia apetala, Licania,* etc. Siendo éstas selvas bastante espaciadas permiten el desarrollo de muchos árboles pequeños, arbustos, tales como *Coccoloba* spp., *Chlorophora tinctoria, Cochlospermum vitifolium, Guazuma ulmifolia, Malvaviscus, Helicteres, Erythroxylon coutarea, Hamelia patens, Jacquinia, Erythrina berteroana,* etc. Las trepadoras de ésta región son: *Paullinia* spp., *Serjania* spp., *Buettneria, Passiflora, Vitis, Cissampelo,* etc. En los lugares áridos y despejados se pueden encontrar *Diphysa robinioides, Tabebuia chrysantha, Psidium* spp., *Ipomoea arborescens, Guazuma ulmifolia, Pereskia autumnalis, Opuntia salvadorensis.* No pequeñas extensiones de lugares áridos y pedregosos del interior del país están cubiertas por *Curatella americana,* la cual a veces lleva como asociada la jícama, *Pachyrrhizus.* Ciertos llanos con suelo barroso y mal drenado durante la época de las lluvias (p. ej. algunos llanos atravesados por el río Lempa o alrededor de San Miguel) están caracterizados por la presencia de *Crescentia alata,* cubierta de epífitas tales como *Tillandsia* y Orquídeas principalmente *Laelia acuminata.* Otra planta característica de éstos suelos es *Blepharodendron mucronatum.*

Allí donde el terreno es húmedo, además de las especies ya dichas, se encuentran *Castilla elastica, Pithecolobium saman, Calycophyllum candidissimum, Pogonopus speciosus, Cecropia mexicana,* etc. Allí también la pequeña palmera, *Bactris subglobosa* forma espesuras impenetrables. En los llanos alrededor del estero de Jaltepeque se dá además abundante la *Brahea salvadorensis.*

En algunos lugares del interior del país, tales como los alrededores pantanosos de las lagunas de Zapotitán y de Olomega, aunque la altura sea distinta reaparece casi la misma vegetación, menos la *Brahea.* En Zapotitán en cambio tenemos abundante la *Erythrina glauca,* la cual en la época de floración presta colorido al paisaje.

Al subir las primeras estribaciones de la Cadena costera además de muchas de las especies ya enumeradas aparecen *Chaetoptelea mexicana, Brosimum terrabanum, Trophis racemosa, Ocotea veraguensis, Licania arborea, Ingo* spp., *Crudia choussyana, Sweertia panamensis, Xanthoxylum microcarpum, Cedrela* spp., *Swietenia* spp., *Sloanea quadrivalvis, Calycophyllum brasiliense* var. *rekoi, Terminalia obovata, Ardisia* spp., *Styrax argentea, Tabebuia pentaphylla, T. donnell-smithii,* etc. En la parte de cadena costera conocida bajo el nombre de costa del Bálsamo, se encuentran bosquecillos de *Myroxylon balsamum* que es allí explotado. Las barrancas de los ríos y las quebradas están bordeadas por *Plumeria acutifolia, Tabernaemontana donnell-smithii, Bursera* y *Spondias* spp.

Los pantanos de agua dulce, ya sea la costa como los del interior del país, presentan la siguiente vegetación: *Equisetum giganteum, Acrostichum, Echinodorus, Canna, Jussieua* spp., *Ceratopteris, Salvinia, Nayas, Pistia stratiotes, Typha angustifolia, Lemna, Eichhornia crassipes, Nymphaea ampla* etc.

Son muy escasas las epífitas de la zona tropical árida inferior. Pertenecen casi todas a la familia de las *Bromeliáceas* principalmente *Tillandsia* spp., orquídeas como *Cattleya skinneri. C. aurantiaca, Oncidium cartaginense, O. ampliatum, Epidendrum* spp. pero también hay varias *Aráceas.* En la costa del bálsamo se encuentra, aunque no muy frecuente.

La zona tropical árida inferior termina entre los 800 y 1000 m de altura, para dar lugar a la zona tropical árida superior en las pendientes de las montañas que miran hacia el sur (el Océano Pacífico) y la zona tropical húmeda superior en las pendientes que miran hacia el norte (el mar Caribe). En El Salvador se hace muy difícil reconstruir la vegetación de éstas zonas, porque, aunque ya se ha dicho, el Café comienza a cultivarse desde unos 500 m. para arriba. Es aquí donde las condiciones son más apropiadas para su cultivo y por consiguiente casi toda la vegetación original ha sido removida para dar lugar a fincas de café, y en los Esesmiles a campos de trigo. Pero aún así se nota una marcada diferencia (más marcada en el occidente del país) entre las pendientes sur y norte de los volcanes y montañas. La porción norte recibe, aún en la estación seca, bastante humedad acarreada por los vientos que vienen de la costa atlántica y por consiguiente presenta una vegetación más exuberante que la porción que mira hacia el sur. Muy poco se sabe de la vegetación de éstas zonas superiores.

Entre las plantas inferiores tenemos *Cibotium guatemalense, Cyathea mexicana, Adiantum andicola, Hymenophyllum* spp., *Lycopodium* spp. En el volcán de San Salvador existían antes, pinares (*Pinus oocarpa*), hoy destruidos. Todavía hay, principalmente en el picacho, bosques de *Quercus* de varias especies. Una asociación de *Pinus-Quercus* se encuentra en las partes más áridas de los Esesmiles. Parece que allí hay otra especie de *Pinus* lo mismo que un *Abies.* En las vertientes sur de los volcanes se encuentran *Myrica mexicana, Baccharis vaccinioides, Cirsium mexicana, Erigeron bonariensis,* etc. En el interior del cráter del Volcán de San Salvador hay *Dahlia variabilis.* Tanto en este volcán como en el de Santa Ana hay bosquecillos de *Perymenium.* Varias especies de *Fuchsias* se encuentran en los Esesmiles, Sierra de Apaneca y en los volcanes de Santa Ana y San Salvador, lo mismo que *Begonias, Rubus, Geranium mexicanum, Gaultheria odorata, Monnina xalapensis,* etc. De las epífitas de éstas zonas muy poco se sabe. En el volcán de Santa Ana se encuentra la *Lycaste skinneri.*

Como se vé, poco es lo que se sabe sobre la distribución de la flora salvadoreña. Si bien es cierto que el estudio sistemático de las plantas del país ha comenzado con las visitas del Dr. P. STANDLEY en los años 1921 y 1922, el herbario comenzado en aquella ocasión ha quedado casi completamente destruido.

Las obras que pueden ser de utilidad para el estudio de la flora salvadoreña son las siguientes: STANDLEY, P. C. & CALDERÓN, S.: Lista preliminar de las plantas de El Salvador (San Salvador, 1926). — Flora Salvadoreña; Herbario FELIX CHOUSSY (Ministerio de Instrucción Pública de El Salvador, 5 vols, 1925). — STANDLEY, P. C.: Flora of Costa Rica (Field Museum Bot. Ser. 18, Vols. 1937, 1938). — STANDLEY, P. C.: Trees and shrubs of Mexico (Contrib. U. S. Nat. Herb. 23, 5 vols. 1920-1927).

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MARIO LEWY VAN SÉVEREN: **Recursos Naturales del Reino Vegetal de El Salvador:** — La República de El Salvador se encuentra situada en la costa del Océano Pacífico en Centro América y al oeste de Honduras. El territorio está formado por una angosta faja de costa cuya anchura mayor es de 100 km. y su largo máximo de 360 km. La atravieza a lo largo una estribación de la Sierra Madre, llamada Cadena Costera y la

cual alcanza alturas de 2000 m. sobre el nivel del mar.

El régimen de lluvias de El Salvador, como muchos otros paises de la costa del Océano Pacífico, es de seis meses, comprendido de mayo a noviembre, siendo secos los restantes meses, es decir de mediados de noviembre a mediados de mayo. Todas las corrientes de agua dulce corresponden a la vertiente del Pacífico y por la vecinidad de las montañas a la costa y por ser el terreno muy accidentado, sus rios son pequeños con excepción del río Lempa.

El Salvador es un país bastante poblado, dado a su pequeño territorio, llegando su densidad de población a 60 habitantes por km. cuadrado, lo cual es solamente superado en la América Latina por Haití; de esta población el 60% es rural. Por dicha razón su territorio está cultivado en su totalidad, con excepción de algunos pequeños bosques que se han podido conservar.

El producto agrícola mas importante es el café y el cual representa el 80% de la exportación total del país. El café fué introducido en El Salvador en 1840, siendo cultivado por primera vez en el Departamento de San Salvador. Antes de la guerra actual se exportaban alrededor de 1.600,000 quintales (de 46 kilos) de café, particularmente a Europa. Esta cifra de producción coloca a El Salvador en el tercer lugar como país exportador de café, estando en primer lugar Brasil y Colombia. Las zonas cafetaleras de El Salvador están distribuidas en las regiones altas del país, entre los 500 y 2000 m. de alt., siendo la más importante la del volcán de Santa Ana que cuenta además con los mejores y más grandes Beneficios del país muy particularmente la de la hacienda "El Molino" de los señores R. ALVARES L. e hijos, que ha sido considerado por expertos extranjeros como el mejor del mundo. Actualmente solo las fincas grandes pueden beneficiar el café y los pequeños productores se ven obligados a venderlo a los propietarios de los beneficios, algunos de los cuales son propiedad de firmas exportadoras que no tienen cultivos propios; pero en la actualidad se está estudiando, en la Estación Experimental en Santa Tecla de la Asociación Cafetalera de El Salvador, el establecimiento en fincas pequeñas, de un tipo de máquina de tamaño experimental para beneficiar 30 quintales al día, habiendose obtenido resultados halagadores.

Sigue en importancia el cultivo de la caña de azúcar, la que se cultiva sobre todo en las zonas central y oriental del país. El cultivo de la caña y la elaboración del azúcar está reglamentado por un organismo semi-oficial denominado "Comisión de Defensa Azucarera" y la cual tiene por fin el mantener estables los precios y fijar las cuotas que cada productor puede elaborar para el consumo interno; el cultivo y elaboración para exportación es libre y se exporta alguna azúcar para Honduras, Nicaragua y América del Sur. Ademas del azúcar, se elabora mucha caña en forma de "Dulce de Panela"; obteniendose por evaporación directa del jugo de la caña, producto que se vende en bloques cilindrico-cónicos de color pardo más o menos claro. La Panela se utiliza en lugar del azúcar entre los campesinos y en la confección de golosinas, pero en la actualidad su mayor consumo es para obtención de aguardiente, licores y alcohol.

El cultivo del henequén ha tomado mucho incremento en el Departamento de San Miguel, donde se cultiva una especie autóctona *Agave letonae*, henequén de gran rendimiento que dá fibra de muy buena calidad. Actualmente sólo se se utiliza la fibra desperdiciándose la pulpa residual y de la cual podría obtenerse muy bien alcohol y papel fino; pero el reglamento de alcoholes no permite lo primero y el poco mercado interior no dejaría margen para la elaboración de papel en escala comercial. El henequén se exporta en cantidades bastantes grandes ya manufacturado en forma de cuerdas y sacos, productos estos elaborados por los mismos campesinos que cultivan la planta. Cuerdas de mejor calidad y tejidos especiales son hechos a máquina en fabricas de mayor capacidad. Los principales paises importadores de artículos de henequén, tales como sacos, son Chile, Cuba, Honduras y Perú. En la actualidad los sacos usados en este país para la exportación del café son exclusivamente de henequén.

El Bálsamo (*Myroxylon balsamum*), impropiamente llamado del Perú, es producido unicamente en El Salvador en una estrecha faja costera de los Departamentos de Sonsonate y la Libertad, región conocida por esta razón como "Costa del Bálsamo." En la época en que el precio del Bálsamo era muy alto, se trató de cultivar estos árboles, pero estas labores se han suspendido primero por el lento crecimiento de estos árboles cuya producción comienza a los 25 años despues de plantados y por la baja de precio de ese producto. La exportación de Bálsamo en estos últimos años ha sido muy pequeña y su reducida explotación se reduce a la de los árboles silvestres.

Puede también contarse entre los productos agrícolas de exportación el algodón, producto que es completamente absorbido por las fábricas de tejidos propias del país y por los pequeños telares rurales que hacen tejidos a mano para el campesino. El algodón se exporta por lo tanto ya manufacturado en forma de telas, hilos y sacos para harina de trigo y azúcar, siendo Honduras y Nicaragua los principales consumidores de los articulos de algodón salvadoreño. A pesar de las plagas que siempre afectan el algodón, el cultivo aumenta mas cada año ya que cada año aumentan las necesidades del país y la exportación.

Otros cultivos de exportación aunque en escala menor son: el añil, el cual por motivo de la guerra ha subido de valor ya que el índigo sintético procedía de Alemania. El cultivo del añil fué muy próspero en el Departamento de Chalatenango y el cual había sido casi abandonado, sembrándose solo el añil como un fertilizante verde. Naturalmente este cultivo volverá a florecer mientras dure la guerra, pues los productos sintéticos son siempre más baratos y fáciles de usar. Sigue en importancia los aceites de semilla de algodón y de *Ricinus communis* (castor oil). El producto primero se consume en su mayor parte en el país y aún se exportan pequeñas cantidades a Honduras y Costa Rica; del segundo se exporta más bien la semilla a los Estados Unidos de América, país que prefiere la materia prima mas que el producto ya elaborado. Se extraen también aceites de cacahuete (peanut) y de ajonjolí (sesame) pero estos solo para el consumo interno.

Los cultivos principales para el consumo interno son el maíz y el frijol, ambos elementos básicos en la alimentación del campesino. El maíz, como en muchos otros paises de la América Latina, se usa como sustituto del pan de trigo.

Estos dos cultivos ocupan una gran parte de la tierra laborable y debido a su importancia se ha creado una entidad autónoma con el nombre de "Junta de Defensa Social," la cual compra grandes propiedades y las distribuye por lotes pequeños a los campesinos, pagando estos con cuotas muy bajas y cultivando en esas fincas principalmente maíz y frijoles. A pesar de la gran cantidad de maíz cultivada en el país es siempre necesario importar pequeñas cantidades de Guatemala, ya que este cereal no solo lo consume el campesino sino también el resto de la población acomodada. En cambio el frijol es más consumido entre la población rural que la urbana.

Las frutas se cultivan en escala cada vez mayor y entre ellas principalmente los cítricos y las bananas entre los cuales se han seleccionados diferentes variedades. Hasta la fecha no se hace exportación alguna de frutas y su cultivo es solo para el consumo nacional. Nuevos cultivos de plantas cítricas como naranjas y limón permitirán el iniciar la exportación de estos frutos. Las legumbres se cultivan en escala pequeña y algunas de ellas se debían de intensificar su cultivo, tales como: repollo, coliflor, apio, remolacha y otras, de las cuales las cantidades producidas son insuficientes para el consumo nacional e importandose estas de Guatemala y California. Ultimamente se ha tratado de intensificar el cultivo de la yuca (*Manihot utilissima*) debido a los precios del almidón en los Estados Unidos de América, pero aún no se pueden prever los resultados de esta campaña.

El trigo se cultiva un poco en las partes altas del país, pero puede decirse que este no representa ni un cuarto del consumo nacional, debiendose importar de los Estados Unidos y del Canada. De la Argentina se quiso importar este grano pero las dificultades de transporte impidió continuar dicho comercio. En la actualidad se está importando de Guartemala y dadas las facilidades obtenidas en un reciente tratado de libre comercio entre estos dos paises, la importación del trigo aumentará cada vez más.

Desde hace algún tiempo se vienen realizando ensayos del cultivo de la rosella (*Hibiscus sabdariffa* var. *altissima*) con fines textiles. Hasta ahora los ensayos hechos en escala semi-comercial han dado resultados altamente satisfactorios esperándose intensificar muy pronto el cultivo de dicha planta.

El problema de los bosques es bastante sensible pues debido a la densidad de población estos van dejando lugar a los pastos, maíz y algodón, de manera que hoy en día quedan muy pocos bosques y estos son pequeños. La falta de los bosques en relación a la humedad particularmente en las regiones altas, no se ha hecho sentir muy fuertemente, gracias a que en los cafetales se reemplazan los bosques naturales con árboles para la sombra que son generalmente leguminosas y muy especialmente del género *Inga*, lo que resulta muy importante en esa region, donde debido a su suelo quebrado no se puede obtener agua fuera de las lluvias. En estos últimos cinco años se ha hecho notorio el efecto de la falta de bosques, y en muchas zonas se han secado las fuentes de abastecimiento de agua y el caudal de los rios pequeños ha disminuido. La legislación vigente prohibe el descuaje de los bosques en las vecindades de las fuentes de agua y a lo largo de curso de estas pequeñas corrientes, medida que no siempre ha sido acatada haciendose necesario tomar medidas un poco fuertes para hacerlas cumplir, muy en particular en la vecindad de las fuentes de abastecimiento de agua de las poblaciones, las cuales son propiedad municipal. Con dicha disposición no se pueden cortar árboles sin un permiso especial y quedando obligado a replantar inmediatamente nuevos ejemplares, los cuales son suministrados por viveros del Ministerio de Agricultura. Estos viveros y los de la Junta de Ornato de Carreteras y Paseos Públicos regala o vende a bajos precios árboles de ornamentación, maderables y frutales al público y a las municipalidades que los soliciten. La municipalidad de la Capital, regala también en Mayo gran cantidad de árboles de todas clases a los agricultores. Todas estas medidas se han tomado para intensificar el cultivo de bosques con árboles útiles pues ya empieza a hacerse sentir la falta de algunos árboles y muy especialmente los árboles maderables tan necesarios para las construcciones y fabricación de muebles.

La erosión ha hecho bastante daños, notandose muy particularmente en el 1934 a raíz de las lluvias de Junio de dicho año, lo cual se debe a lo accidentado del terreno que ha obligado cultivar las tierras aún en pendientes muy fuertes. En los cafetales del volcán de Santa Ana donde en ciertas partes era imposible cultivar nada por los deslaves, se ha logrado controlarlos y cultivar café en ellos, gracias a empalizadas de izote (*Yucca elephantipes*) las cuales se mantienen bajas con cortes anuales y sus raices hacen una trama tan fuerte que impide por completo la erosión. Para evitar esto se ha prohibido el cultivo de cereales en terrenos muy inclinados y en particular alrededor de los lagos de origen volcanico cuyas colinas circundantes son muy inclinadas. Estos lagos han subido de nivel a causa de la erosión y sobre todo de la acaecida en 1934 cuando subieron cerca de cinco metros, mas por la erosión que por el agua acumulada; con la actual prohibición el nivel de las aguas se mantiene perfectamente estacionado. El régimen de lluvias como he dicho en párrafos anteriores es más o menos constante en cuanto a las épocas se refiere. Como el cambio de las estaciones no se hace sentir mucho sobre la vegetación, se toma sólo en consideración la estación seca de noviembre a mayo y la de lluvias de mayo a noviembre ésta con un promedio de cincuenta días de lluvia y aproximadamente una precipitación anual de 1.800 mm. La temperatura es mas bien cálida y constante con un promedio de 23° C. y una máxima de 32° C. que se registra generalmente en el mes de marzo y una mínima de 15° C. que se registra en diciembre o enero. En general la temperatura es igual en todo el país y solo la modifica la altura.

El Salvador cuenta con buenas vías de comunicación tanto para el interior como con los paises limítrofes siendo su red de carreteras transitables en todo tiempo y varias de ellas están asfaltadas. Comunica con ferrocarril con Guatemala, vía que sirve a la vez para comunicar con el atlántico por Puerto Barrios. Dos compañias de ferrocarril cruzan el país en todas las zonas mas importantes. Sus puertos son Acajutla, La Libertad y La Unión (Cutuco), el primero y el último conectados por ferrocarril y La Libertad está unida a San Salvador por carretera asfaltada. Puerto Barrios de Guatemala, es un lugar de salida de mucho café para la costa del Atlántico de los Estados Unidos de América. El servicio

de transporte aéreo se hace al exterior por medio de la Pan American Airways Co. y con Centro América por medio de la Compañía de Transporte Aéreos Centroaméricanos (Taca) y la cual lleva gran cantidad de mercaderías a Honduras. El servicio de transportes aéreos interior no existe debido a lo reducido del territorio nacional.

En el Salvador existen dos Estaciones Experimentales; una en la Ceiba a 6 km. de San Salvador y la cual pertenece al Ministerio de Agricultura y donde se hallan instalados los laboratorios de Agricultura; la otra Estación Experimental está situada en la ciudad de Santa Tecla y pertenece a la Asociación Cafetalera de El Salvador donde se estudia principalmente lo relativo al café, llevandose también a cabo investigaciones de índole agrícola en general, contando además con laboratorios especiales para el estudio de plagas agrícolas.

MINISTERIO DE AGRICULTURA,
SAN SALVADOR.

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JOHN ASHTON: **On the Plant Resources and Flora of Nicaragua:** — Because of its fertile soils and varied topography, its shores bathed by two oceans, and lying between 10 degrees 45 minutes and 15 degrees 15 minutes north latitude, the republic of Nicaragua is one of the most interesting countries in the world for the wealth and variety of its agriculture and flora in general.

Singular to state, this small country—it is the largest of the Central American countries and is about equal in area to the State of New York—seems to be the least known of all the Latin American countries north of the equator, but signs and portents point to an expanding commerce and a better mutual understanding between the two countries in the future.

Nicaragua is singularly blessed by Nature from the fact that two mountain chains traverse the country in a general direction of northwest-southeast, thus making for marked differences in the prevailing temperatures of the interior, phenomena reflected in the remarkable latitude which these divers climates and precipitation offer to the plant life of the country. These differences, however, are not so extreme as one finds in other tropical countries at times, because the mountains of Nicaragua, while very numerous, are not very high. On the other hand, many grassy plateaus at moderate altitudes, on soils unsuitable for arable exploitation, nurture large herds of cattle under almost ideal conditions. About seven-eights of the people live on the Pacific slope, within about 30 miles of the ocean. This region is particularly suitable for farming, the rainfall varying between about 60 or 70 inches, nearly all, of course, coming in the wet season—between May 15 and November 15. In the interior the rainfall is greater until, on reaching the Atlantic Coast, areas of between 200 to 300 inches precipitation are not uncommon, thus precluding ordinary methods of arable farming.

A growing appreciation of the advantages of irrigation in favored areas of the tropical Pacific Coast will eventually result in an increased yield of certain crops proper to the tropics and valuable as export money crops. With an enormous body of fresh water within easy reach in the two great lakes of Managua and Nicaragua—the latter almost one hundred miles long and one of the largest bodies of fresh water in the world—the time seems not far distant when some of this potential wealth will be effectively exploited.

*Principal Crops.* — In normal years Nicaragua produces 320,000 quintales (a *quintale* is equal to 100 pounds) of coffee. This forms the chief money crop of the country as all of it is exportable save about 20 to 30 thousand quintales consumed at home; most of this domestically consumed coffee, however, is made up of qualities not suitable for exportation. Under present conditions the United States takes most of the coffee crop, one-third of which is grown on the higher lands just south of the capital, Managua, and a little more than a third of the coffee is produced in the department of Carazo in the rich agricultural region known as Los Pueblos (Masaya, Jinotepe, San Marcos, Diriamba, Masatepe, etc.).

The finest coffee is reputed to be grown in the departments of Matagalpa, Jinotega, and Nuevo Segovia. All this northern-grown coffee produced from higher plantations is sold as "Matagalpa" coffee and is in particular demand by American importers of the finer blends. It sells normally a little higher than the regular export crop. It should be observed, however, that all Nicaragua coffee exported is in active demand on the part of American coffee blenders for its mildness and fine aroma and taste. During the last few years better harvesting and processing methods have improved the Nicaragua crop immeasurably.

Nicaragua stands twelfth among the nations of the world in coffee production. It is estimated that the number of trees in the republic is fifty millions, with an average yearly production of one-half to three-quarters of a pound to the tree.

*Bananas.* — Banana growing which formerly held so much promise for Nicaragua is in a transition stage owing to the inroads of the banana plant disease *sigatoka* on the Atlantic Coast. This disease has also played havoc with many plantations on the same coast in Costa Rica, and the United Fruit Company there is making great efforts to transfer the industry to the Pacific Coast. Similarly, certain interests have made laudable attempts to establish banana plantations on the Pacific side in Nicaragua,

but without marked success as yet, due to various obstacles, one of which has been the dearth of ships plying between the Pacific port of Corinto and the U. S. It has been proposed to dry bananas for shipment, just as is done in the case of figs and dates.

Certain haciendas which have access to water for irrigation purposes adjacent to the Pacific coast could produce large quantities of this fruit provided adequate transportation facilities to market are assured in season. In spite of the difficulties banana export comes next to coffee in importance.

Other crops exported are cotton, sugar cane, cocoa, rice, sesame, castor oil, tobacco, ipecacuana root, balsam of Peru, rubber, hides and skins, live turtles, cattle on the hoof (mainly to Peru), etc. Some of these products find a foreign market only when market conditions warrant their export.

*Timber Resources.* — Nicaragua is rich in forest growths and produces considerable quantities of hard woods, dyewoods, and timbers suitable for construction purposes. The king of fine woods, mahogany, has been exported from the country for generations, especially to European ports.

Many of Nicaragua's mountains and river valleys have scarcely been exploited—some probably have not even been explored—and hide in their almost inaccessible jungles immense treasures of fine woods suitable for cabinet-making, construction purposes, etc. Prominent among these growths are mahogany, cedar, pochote, rosewood, quebracho, laurel, guaiacum, and a host of other valuable timbers which grow in great abundance and luxuriance, in many parts of the country, but more especially on the Atlantic slope.

Among the medicinal products of these forests may be mentioned sarsaparilla, wild ipecauana, gentian, Peruvian bark, vanilla, balsam of Peru, etc.

*Sugar Cane.* — Nicaragua produces sugar in abundance and could, if permitted by the U. S., send a great deal to this country in case of necessity. As a matter of fact the principal sugar mills are obliged to stringently restrict their output to domestic needs chiefly. Occasionally lots of brown sugar—50 to 150,000 quintales—are exported to the U. S. Some white sugar is also exported to Pacific coast ports, but the U. S. does not allow this to compete with our home product and it normally is used only for syrup in which to pack California fruit for export.

*Other Useful Plants.* — The flora is immensely rich, thanks to its tropical climate and abundant rainfall in some regions and also to its varied topography and climates to correspond to the altitude.

Among its food plants maize (*Zea mays*) comes first. It forms the chief staple of the masses and is eaten normally as in Mexico in the form of baked tortillas. A great quantity is also consumed in beverage form; a large percentage of the population drink the national *tiste*, or "pinol," made from toasted maize, ground, mixed with sugar and cocoa or chocolate, stirred in water. Only the sugar dissolves completely, the other ingredients are more or less in suspension when swallowed. This mixture is immensely popular; it is food and drink at the same time, wholesome and nourishing.

Wheat (*Triticum sativum*) is grown only in certain favored regions on the higher plateaus—Jinotega, Esteli, etc.—where the temperature is low enough to permit it. Wheat production is slowly increasing.

"Yuca" (*Manihot dulcis* or *utilissima*) is a root plant the consumption of which by the natives assumes very large proportions. This plant undoubtedly is one of the most useful in the tropics. Never a day passes but one sees heaps of these succulent roots offered for sale in the central market of the capital at Managua. It is rich in starch and used largely in soups or simply boiled. The bitter "yuca" is also grown.

"Quequisque" or "quiquisque" (*Xanthosma sagittifolium*), another edible root of immense utility to the native population, could be eaten with great profit by American residents and visitors as the starch in this root is easily digested. It is, moreover, of agreeable flavor. The writer and his wife can vouch for the wholesomeness of both this root and the "yuca" which were eaten regularly in soups based on beef stock. The consumption of both these excellent root crops is enormous in Nicaragua. The "quiquisque" is a yautia.

"Platano" (*Musa paradisiaca*), perhaps next to maize or Indian corn, is the most widely consumed and popular foodstuff for the working classes in towns and the rural population generally. This fruit is in great demand and its popularity is not diminished by the fact that it is perhaps the cheapest of all starchy foods. It is eaten boiled or fried usually, either alone or with meats or other comestibles, and is on the market throughout the year. This plant should not be confused with the banana (*Musa sapientum*) which is grown mainly for export and is consumed raw.

Pineapple (*Ananas sativus*) of excellent quality is grown in the more tropical areas of the republic.

"Aguacate" (*Persea americana*) also grows luxuriantly and fruits well in many areas. Both the pineapple and the aguacate could be developed profitably for export trade here, it would seem.

"Mango" (*Mangifera indica*) grows to a large size and usually bears twice a year, finding conditions, in the lower areas, greatly to its liking. This fruit is eaten with the greatest avidity by the native population, who are not particular whether the fruit is ripe or not. When ripe the mango is rich in sugar content; it is probably rich in vitamins also. It grows to a height of 70 feet, and is one of the handsomest of trees.

"Marañon" (*Anacardium occidentale*) is a tropical tree which produces the exotic and relatively rare cashew nut, of exquisite taste when roasted.

The nut is the true fruit and grows on the under side of the cashew-apple, which is really the swollen peduncle and disk, and is astringent but juicy, acid, and finds favor with the natives, who normally throw away the nut. Americans do not eat the apple but prize the nut which must be roasted over charcoal fire to decompose the injurious acid substances in the shell which burn the lips and mouth of those who attempt to bite into the fresh nut. When roasted there

is no danger. The kernel is very rich in proteins and fats.

Papaya (*Carica papaya*) is abundant and common everywhere. Unlike the flavor of papayas commonly grown in the lower Rio Grande Valley, the Nicaraguan varieties are delicious and have none of the objectionable taste associated with papayas at home. Usually served as dessert or a side dish with milk or cream or lime juice, the papaya is a favorite with native and visitor alike. The fruit grows to an immense size, and its food value cannot be overestimated.

"Zapota" (*Calocarpum mammosum*) is also much in demand as a dessert fruit. The pulp is bright reddish or orange, sweet and spicy and agreeable in flavor. One large shining brownish black seed is embedded in the fruit. It is usually eaten out of hand. The seed when roasted is also edible and is mixed with cocoa. It grows into a large and handsome forest tree. Monkeys feast on this fruit in the jungles.

"Nispero" (*Achras zapota*) is the most popular of the *Sapotaceae*. The same fruit is known as the "sapodilla" in many other countries, but invariably called the *nispero* in Nicaragua. It should not be confused, however, with the European medlar as some botanists have done. It has been called also *chico* and *naseberry*, and is native to tropical America and was found growing by the conquistadores early in the sixteenth century. OVIEDO called it the "best of all fruits", and a French writer (DESCOURTILZ) has described it as having the "sweet perfumes of honey, jasmine, and lily of the valley". It was eaten freely as a dessert fruit by the writer during his stay in Nicaragua, who, like most Americans, rates the "nispero" higher than the "zapota."

Sweet "Granadilla" (*Passiflora ligularis*) and Purple "Granadilla" (*Passiflora edulis*) are grown chiefly for their edible fruits. The latter variety is the most important. It is used for flavoring sherbets and in confectionery and *refrescoes* with a pinch of bicarbonate of soda.

*Jocote* or red *"mombin,"* grows abundantly over a large area of different levels and is cherished as a fruit to be eaten out of hand by the natives. The "jocote" (*Spondias mombin*), to give it the name by which it is known in Nicaragua, has many other names, according to the country in which it is grown. The French colonists call it *prunier d'Espagne, prunier rouge*, and *mombin rouge*. In the English colonies of the tropics it is called Spanish-plum. One sees people of all degree eating this fruit in trains, in the streets, etc. It is also boiled and dried to preserve it, and may be kept this way for several months. The yellow "jocote" or "mombin" (*Spondeas lutea*) is not so highly prized as the red variety.

Breadfruit (*Artocarpus communis*). The writer saw no more handsome foliage than that of the breadfruit during his stay in Nicaragua. It grows into a noble tree, 40 to 60 feet in height, and the visitor to the capital cannot fail to be struck by its beauty as nearly every private garden contains one or more specimens. Frequently one sees the mango and the breadfruit growing side by side, both particularly handsome, the former with lanceolate leaves of a refreshingly light green color, and by contrast the breadfruit bears enormous leaves of characteristic design and rich dark green in color. Whether it is because Nicaraguans are blessed with an abundance of sweet and starchy foodstuffs, or for some other reason, the writer saw no evidence of the breadfruit being much in demand for its fruit, rather does it seem to be grown in the urban centers for its beauty as an ornamental tree.

Pomegranate (*Punica granatum*) is used commonly to prepare a cooling drink called grenadine, and in other *refrescoes*.

"Mamey" (*Mammea americana*) is a handsome tree of truly tropical aspect with pronounced dark green "meaty" leaves of lustrous sheen 4 or 5 inches long. Whether one meets the mamey in a secluded jungle ravine or in the cultivated garden of a wealthy planter he recognizes this handsome tree at once with its full top of foliage on strong branches.

The fruit finds much favor in season on the part of the natives. It is one of the largest tropical fruits, of varying size, some of which are as large as a coconut and bear some resemblance to it in color. There, however, the similarity ends, the pulp being entirely different. Only the country people eat the "mamey" raw, as a rule, but many enjoy the fruit when cooked with plenty of sugar and spice. Some make it into paste, which is, however, not considered so good as the "pasta de guayaba." The tree rapidly attains full growth in good soil and may attain a height of from 40 to 60 feet. One finds it planted freely in the borders of coffee plantations as a protecting cover for the young coffee plants.

Orange (*Citrus sinensis*) trees grow luxuriantly on the best soils and are eaten freely throughout the year. The sour or bitter orange (*Citrus medica*), the mandarin (*Citrus nobilis*), the lime or "limon corriente" (*Citrus aurantifolia*), and the lemon or "limon real" (*Citrus limonia*) are found on the market most of the time and are consumed in abundance for making the popular *refrescoes* or cooling drinks.

Grapefruit or "pomelo" is also popular to a degree, especially on the part of American visitors. Certain kinds of the fruit from Chinandega are sweet and show good quality, but most of the grapefruit is high in "rag" content and contains many seeds. A budding program on an extensive scale with improved budwood is indicated. A beginning was made when the writer procured from Texas one thousand buds of improved varieties of oranges and grapefruit from Texas in May, 1941, for Nicaraguan citrus groves. Rivas grows perhaps, with Chinandega, the best citrus fruit, and these two departments are also noted for quality in other fruits.

"Anona." Under this name the native Nicaraguan eats several varieties of *Anonaceae*, such as the delicious *"guanabana"* (*Anona muricata*), "anona blanca" (*A. diversifolia*), "chirimoya" (*A. squamosa*), Guatemala "anona" (*A. cherimolia*), and perhaps others.

Yams (*Dioscorea alata*) are not grown as freely as they might be, notwithstanding that Nicaraguan soils lend themselves to yam cultivation, as is suggested by the fact that the wild yam is found almost everywhere (*D. bulbifera*), and is known vulgarly as the *papa* (potato) *carib*.

Sweet potato (*Ipomoea batatas*) is grown extensively on the Atlantic coast as a food plant.

Beans (*Phaseolus* sp.) do well almost everywhere and form an important portion of the inhabitants' food. Some of the varieties are similar to beans grown in Mexico and the United States, but other sorts are proper to the country. One variety seen exposed in markets has a pod about a yard long.

Vegetables in general. — Virtually all the common garden vegetables of the temperate zone are grown in Nicaragua. This fact stems from the variety of soils and climates due to the diversified topography in the interior. One common American fruit seems to be absent—the apple, which is a great luxury and only appears on the market in the cooler months shipped from U. S. ports. The peach is almost as scarce.

*Timber Wealth of Nicaragua.* — One realizes what words like "jungle" and "tropical forest growth" mean after seeing the wealth of plant life growing in Central America, where neither frosts nor drouths intervene to prevent the growing "impulse" of plant life. The beauty and majesty of many forest trees which one sees for the first time is beyond adequate description. Some of these—lack of space precludes more detailed mention—should be listed for their economic importance. In some cases the trees assume enormous dimensions of trunk with great spreading branches, and as for the size of the trunk one can visualize it when told that in innumerable cases one can find native wheel-

wrights carving ox-cart wheels (a pair)—cut vertically, not horizontally, and side by side—from say the massive trunk of a giant "guanacaste."

On the lower rims and reaches of the numerous mountains and extinct volcanoes and in some of the river valleys which slope toward the Atlantic coast forest trees of great dimensions are seen. Even in some of the well watered valleys on the Pacific slope many noble trees are seen shooting up to immense heights from mountain chasms with nearly all the foliage on the summits of the trees.

The regal and beautiful mahogany (*Swietenia mahagoni* and *Swietenia macrophylla*) may be regarded as the king of the forest in these tropic lands. It was formerly exported in ship loads to Europe, and is still a popular wood with European cabinet makers—when they can get it. Much of the mahogany trade at present centers about the river Coco in northern Nicaragua, the logs being floated down the river to the Atlantic coast for loading. The same system applies to the other fine woods found there. Much timber from these forests could be profitably used by the United States for various defense purposes. Some of these woods should find a place in shipbuilding uses.

Perhaps one of the most useful of all timbers, particularly useful for construction purposes, is the "pochote" (*Xanthoxylum microcarpum* and *Xanthoxylum panamense*). Many millions of feet of this very durable and non-warping lumber have gone into the reconstruction of Managua since the devastating earthquake of March, 1931, virtually destroyed that city.

Among the cedars much in demand for building are the *Cedrela mexicana, C. fissilis, and C. longipes.* For river-boat building the "palo de piragua" (*Cavanillesia platanifolia*) is much in demand. Other construction woods are the "gatillo" or "balsa" (*Ochroma lagopus*), "talatate" (*Gyrocarpus americanus*), "aceituno" (*Simaruba glauca*), "guanquero" or "cedro macho" (*Guarea guaro*), several varieties of pine, such as "el ocote" (*Pinus tenuifolia*) which grows freely in the higher departments—Jinotega, Esteli, etc.—"el pino" (*Pinus caribaea*) and other varieties.

Some emphasis should be made regarding the two forest giants which are so useful and so numerous in Nicaragua—the "genizaro" (*Pithecolobium saman*) and the "guanacaste" (*Enterolobium cyclocarpum*). Both are noble trees which embellish the landscape with their massive trunks, great height, wide-spreading branches, and rich foliage. Both enter largely into the building of carts and wagons, river launches and boats, rural buildings of all descriptions. The best wheels that can be made for the ox-carts, so numerous in Nicaragua, come from the guanacaste tree.

Among the trees which provide fine woods, besides mahogany, are the "guayacan" (*Guaiacum sanctum*), "cocobolo" (*Amyris balsamifera*), the "nispero" or chicle tree (*Achras sapota*), "madero" (*Gliricida sepium*), "granadillo" (*Brya nicaraguense*), "guachipilin" (*D physa robinioides*), "cortez" *or* "palo de hierro" (*Tabebuia pentaphyla*), "cortez blanco" (*Godmania aesculifolia*), "laurel macho" (*Cordia garascanthus*), "el ronron" (*Astronium graveolens*), and many others.

*Dyewoods.* — Among the numerous dyewoods growing wild in the forests two of much commercial value should be listed: "palo de mora" (*Chlorophora tinctoria*), and Brazil wood (*Haematoxylon brasiletto*). It is also thought that the noted Campeche tree (*Haematoxylon campechianum*) also exists in the hidden jungles of the country. Of less importance are the "chocamico" (*Ximenia americana*), the "nancite" (*Byrsonima crassifolia*), and others.

*Timbers containing Resins and Gums.* — Numerous are the trees which secrete resins and gums of more or less commercial value. Among these are various species of rubber trees, more especially those of the genus *Ficus*, the most important being "palo de hule" (*Ficus elastica*); that known as white rubber (*Manihot glaziovii*) of the family of *Euphorbiaceae*, very common, and several species of the genus *Castilla*, such as *Castilla costaricana, Castilla fallax,* and *C. panamensis.* Other trees producing gums of various sorts are the "guapinol" (*Hymenaea courbaril*), the wax tree (*Myrica mexicana*), very common on the northern plateaus, the product of which is used for the manufacture of candles and soaps, on a modest scale. Then there is the "jinocuavo" (*Elaphrium simaruba*).

From the *Pinus tenuifolia* is extracted turpentine. This could be greatly increased if better transportation facilities existed. The "nispero del monte" or chicle tree has gained much importance recently for its milky latex which, when evaporated is known as chicle, the base for chewing gum, virtually all of which is exported to the United States.

A representative of the largest manufacturer of this product in the U. S. was staying at the same hotel as the writer when in Managua. He made numerous visits to the outlying forests on the Atlantic slope in periodical surveys for his employers.

"Cachito de Aromo" (*Acacia farnesiana*) grows abundantly near Managua. This is the same tree from which acacia essence on a large scale is extracted in France. Vanilla (*Vanilla planifolia*) grows wild in Chontales department.

Other plants and trees contain toxic principles which find a place as curative agents in human medicine and as insecticides. Some of these are destined eventually to acquire much importance.

*Palms.* — Nicaragua is extremely rich in species and varieties of palms, some of which possess positive industrial value. Among the more important are:

Coconut palm (*Cocos nucifera*), great numbers of which grow on the Atlantic seaboard and are cultivated on a lesser scale throughout the country. Besides its export value the coconut is used extensively for its oil, utilized in the manufacture of toilet soaps. The natives drink a great deal of coconut milk also.

"El corozo" or "palma de vino" (*Acrocomia venifera* or *A. mexicana*), also produces oil for soap making. This tree yields a sugar which, when fermented changes to an alcoholic drink said to be much appreciated by rural people.

Among the tinctorial plants the "anil" (*Indigofera suffruticosa*) is still found growing wild in the forests. Then there is the "achiote" (*Bixa orellana*) often seen growing in patios. There are many others of less value, such as "sacatinta" (*Sericographis tinctoria*), "pinta machete" (*Phytolacca octandra*), "tina canastas" or "llora sangre" (*Bocconia arborea*), etc., etc. "Cohune" or "coyol" (*Attalea* sp.) is found abundantly in the woods and forests whose seeds yield an oil of high quality much in demand on foreign markets.

"Pijibay" (*Guilielma utilis*) is a palm which yields fruit in bunches about the size of large olives which are commonly sold in the markets and on the streets of Managua (also in San José, Costa Rica). They contain food properties much in demand and are generally boiled before eating. The flavor is much like that of boiled chestnuts.

"La tagua" or vegetable marble (*Phytelephas macrocarpa*) is a tree of much value on account of the peculiar properties of its nut, the pulp of which hardens to form an excellent substitute for marble. It grows extensively on the Atlantic coast and, especially, in the watershed of the San Juan river.

"El coquito palmiche" or "corozo colorado" (*Elaeis melanococca*) grows profusely in swampy land. Its fruit is said to be as rich in oil as its congener from Africa (*Elaeis guineensis*).

"Palma de techo" or roofing palm (*Astrocaryum*) is used largely for covering rural homes and cabins, and also to make brooms and hats. *"Palma de cera"* (wax palms) are found growing on the banks of the San Juan river and have been classed by the erudite Nicaraguan naturalist, MIGUEL RAMIREZ GOYENA, as *Copernicia cerifera* and *Ceroxylon andicola.* Decorative palms include the "palma real" (*Roystonea regia*), one of the most handsome of all plants used for bordering roads and avenues; the "cola de pezcado" (*Caryota obtusa*), much planted in parks and gardens; the Cuban palm (*Sabal umbraculifera*) and the "sabal taurina."

Among the plants which produce essential oils and perfumes should be listed—"Zacate (grass) de limon" (*Cymbopogon citratus*). This grass is grown in India on a large scale for the production of essence. "Ylang-Ylang" (*Canangium odoratum*) is introduced from Japan, the flower yields a perfume much in demand, especially for the manufacture of Kanaga water.

It should be understood that this article makes no claim to completion. A great number of useful trees, including the quick-growing species used for shading coffee trees and for avenues, etc., are not mentioned.

Neither has there been space left to tell about the various fiber-producing plants like henequén, sisal, abaca, etc.

The latter—"abaca" or Manila hemp (which is not a hemp at all, but a banana plant, even to producing fruit, which is not edible) can be successfully grown in Nicaragua as is proved by the fine plantation on one of the President's farms—El Porvenir—near San Marcos. Incidentally, the President of Nicaragua, General ANASTASIO SOMOZO, is intensely interested in the agricultural and economic uplift of his country, and shows a fine example to his people by breeding fine livestock on his haciendas and introducing forage plants, textile plants, and every other field crop or tree which is suitable for economic and industrial exploitation. He is aided in his endeavors by his progressive Minister of Agriculture, General JOSÉ M. ZELAYA, a one-time student at Cornell, whose interest in the experimental farm at Masatepe has borne much useful fruit. General ZELAYA has also fostered the introduction of fine cattle from the United States to build up the Nicaraguan herds.

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PAUL C. STANDLEY: **A Brief Survey of the Vegetation of Costa Rica:** — Costa Rica is one of the smallest of American republics, with an area of only 18,400 square miles, approximately that of the state of West Virginia. Its flora is extraordinarily rich, of at least 6,000 species. In all the tropics there can be few areas of equal extent with so many species. Of orchids alone it possesses about 1,000 species.

Costa Rica is bounded on one side by the Caribbean, on the other by the Pacific Ocean. Most of its surface is extremely rugged, and even relatively level land is restricted to the narrow coastal plains. The greater part of the country consists of a chain of volcanoes, rising to 3,900 meters and forming part of the cordillera that extends like a spinal column along the western edge of the American continents. Most of the small population of Costa Rica is massed in the so-called Meseta Central, a limited irregular area of level land at an elevation of 900-1,500 meters, devoted largely to coffee production, and bounded on all sides by hills or high mountains. The Meseta lies much closer to the Pacific than to the Atlantic. On the Pacific side are narrow plains utilized for stock raising and cultivation of tropical crops; on the Atlantic coast are wider plains where bananas and cacao are grown.

The dominant factor in plant distribution in Central America is rainfall, which is influenced by elevation, placement of the mountain ranges, and direction of the winds. On the Atlantic coast of Costa Rica moisture conditions are fairly uniform throughout the seasons, and rainfall is heavy, in some places reaching 180 inches per year. There always is sufficient moisture for luxuriant plant growth. On the Pacific slope the rainfall is less than half as great and periodic. During the *invierno,* May to October, the whole rainfall of the year is received. During the warmer *verano,* coinciding with the winter months of the North, there is little rain and for most of the season none whatever. For only half the year is there moisture enough for normal plant growth, and the cultivation of field crops is restricted to the *invierno.* On the Atlantic coast maize, beans, and other crops are produced throughout the year.

The vegetation of Costa Rica has been studied from a taxonomic standpoint more intensively than that of most Latin American countries, by a long line of visiting and resident botanists from the Danish OERSTED up to the present time. Until very recently no other tropical American country had received so much attention from resident botanists. In spite of the small area involved, its irregular topography makes exploration difficult, and there are many areas, presumably quite as rich as those already explored, that never have been visited by a botanist, such as the highest peak of Costa Rica, Chirripó. Almost every new collection contains species new to the country or to science, and new species still can be found almost in the suburbs of San José, the capital. It is safe to assume that in Costa Rica there are no fewer than 7,000 species of phanerogams, besides a vast number of ferns and lower cryptogams.

No serious study has been attempted of Costa Rican plant ecology, and it will be a complicated and difficult subject. Except in the broadest generalities, the vegetation superficially does not seem to lend itself readily to detailed classification. The plant societies are infinitely complex and numerous, and consist of what appear to be indefinite and casual combinations of conspicuous plants. More general groupings, dependent upon rainfall and elevation, are rather obvious although seldom with well marked boundaries. These are discussed briefly below.

*Atlantic tierra caliente.* — This consists of the Caribbean lowlands, between sea level and 800-1,000 meters, with a mean annual temperature of 21-28 degrees. Except where cleared for agriculture — bananas, maize, beans, cacao — this is unbroken rain forest, a rather monotonous expanse of tall trees of varied families, with an

understory of medium-sized trees equally diverse, and beneath these a sparse ground cover of low shrubs and large or small herbs. The only variant is the tenuous ribbon of beach and shore vegetation bordering the coast, the conventional mangrove swamps and the customary strand association of *Ipomoea Pes-caprae, Canavalia maritima, Cakile, Sesuvium, Philoxerus,* and the like.

Land for a time under cultivation and then abandoned soon is overgrown with weedy shrubs and trees such as *Cecropia, Luehea, Apeiba, Triumfetta, Ochroma, Trema, Spondias,* and many melastomes. Fresh-water, open or wooded swamps and marshes, often of considerable extent, are dominated by *Calathea, Thalia, Canna, Cyperus giganteus,* and ubiquitous plants like *Pistia, Sagittaria, Nymphaea, Pontederia, Eichhornia,* and *Limnanthemum.* Typical swamp trees are *Mora, Pterocarpus, Raphia, Corozo,* and *Manicaria.*

Upland forest covers most of this Atlantic lowland area. Dominant or abundant trees are *Pentaclethra, Luehea Seemannii,* various *Lauraceae* of the genera *Ocotea, Nectandra,* and *Phoebe;* species of *Ficus, Coussapoa, Brosimum, Ogcodeia, Perebea, Poulsenia, Symphonia, Hippomane, Minquartia, Virola, Compsoneura, Dialyanthera, Prioria, Dialium, Dipteryx, Zanthoxylum, Protium, Swietenia macrophylla, Vochysia, Terminalia, Manilkara, Jacaranda, Castilla, Chrysophyllum,* and many others, and such endemics as *Lecythis costaricensis* and *Theobroma simiarum.*

In the understory are palms of the genera *Socratea, Welfia, Astrocaryum, Euterpe, Geonoma, Iriartea, Reinhardtia,* and *Chamaedorea,* and trees like *Didymopanax, Pourouma, Carica dolichaula, Inga* and *Pithecolobium, Dracaena, Ravenia, Guatteria, Guarea,* and *Carapa.* Beautiful tree ferns abound in favorable regions. Shrubs are numerous, including species of *Piper, Heisteria, Siparuna, Swartzia, Quassia, Neea, Cupania, Psychotria,* and many other diverse groups. Herbaceous plants are few and of limited growth because of the scant light reaching the ground. There are a few broad-leafed grasses and many coarse *Monocotyledoneae,* like *Heliconia, Calathea, Dieffenbachia, Renealmia, Costus,* and *Xiphidium.* Epiphytes are luxuriant, especially such plants as *Anthurium, Philodendron, Monstera,* and *Carludovica.* There are many common ferns; orchids are numerous but usually high in the trees. Celebrated among them are the *guaria de Turrialba* (*Cattleya Dowiana*), *Vanilla,* and *Peristeria,* the Dove or Holy Ghost orchid. Among small herbaceous plants are many *Acanthaceae, Carludovica* and *Cyclanthus, Selaginellas,* and *Rubiaceae.* A caulescent *Zamia* abounds in many parts of the Atlantic lowlands.

*Pacific tierra caliente.* — In the Pacific lowlands with their relatively scant rainfall there is little to suggest a conventional tropical vegetation, the aspect of the plant covering being somewhat like that of southern Texas. For half the year the plants are more or less dormant, their leaves withered or fallen. After the first rains, the trees burst into flower and leaf and suggest the spring vegetation of the North. Here there are giant trees, among the tallest of Central America, such as *Hura, Enterolobium,* and *Ceiba pentandra,* but otherwise most of the trees are smaller than those of the Atlantic lowlands. There are broad expanses of savanna or grassland, brown and dry during the winter months of the North but vivid green after the first rains. The savannas afford innumerable grasses and sedges and such low herbaceous plants as *Cipura, Polygala, Curtia, Melochia, Hyptis, Centrosema, Sauvagesia, Crotalaria, Eriosema, Stylosanthes, Zornia, Evolvulus, Buchnera, Ruellia,* and *Borreria.* There are shallow seasonal pools with aquatics of the genera *Schultesia, Bacopa, Limnanthemum,* and *Nymphaea.*

The larger trees of the Pacific forests include *Anacardium excelsum, Licania platypus, Sterculia apetala, Ficus, Platymiscium, Pithecolobium Saman, Sweetia, Lauraceae* and *Sapotaceae, Tabebuia pentaphylla, Triplaris, Cordia alliodora, Cassia grandis, Bombax* and *Bombacopsis, Terminalia, Cedrela, Gyrocarpus, Calycophyllum, Andira inermis, Dalbergias,* and a host of others. Of smaller trees there are *Dipterodendron, Byrsonima, Coccoloba, Tabebuia chrysantha, Hymenaea, Crataeva, Caesalpinia, Cochlospermum, Chlorophora, Guazuma, Trophis, Plumeria rubra, Sloanea, Annona purpurea, Rollinia, Diphysa, Psidium, Simaruba glauca,* and *Muntingia.*

In the Pacific tierra caliente grows the only tree cactus of Costa Rica, *Cereus Aragoni.* The palms include *Bactris, Acrocomia vinifera, Desmoncus, Pyrenoglyphis,* and *Scheelea.*

*Temperate region* (*Tierra templada*). — The temperate region (*tierra templada*) of Costa Rica embraces the mountain slopes and some relatively level country between 800 and 1,500 meters. It includes most of the uplands, and excludes only the limited cold regions about the mountain summits. Like so many other plant belts, it is transitional and seldom sharply limited. It includes all the coffee plantations and extends somewhat higher. There is considerable difference between the floras of the Atlantic and Pacific slopes, due to lesser rainfall on the latter, but on the whole the temperate flora is rather constant in its general elements and aspect although infinitely varied as to species, many of which are local or erratic in distribution.

The most curious aberration is in the mountains of the cordillera of Guanacaste, one of the lowest parts of the continental backbone. On account of their insignificant elevation, about 600 meters, the mountains of the Tilarán region should fall in the *tierra caliente,* but because of the unique distribution of rainfall — rain clouds advancing from the Caribbean throughout the year and discharging their water on their low slopes — the flora is actually much like that of central Costa Rica, at 1,500 meters.

The *tierra templada* originally, but perhaps only many centuries ago, was wholly covered with dense mixed forest, the greater part of which has been cleared for cultivation, and the clearing still continues. In this forest oaks (*Quercus*) predominate, at least over large areas. From bits of it remaining in the central region, one can see that the primeval forest possessed great beauty, with many huge trees which, especially at higher elevations, were often covered with epiphytes, particularly orchids and ferns. The trees usually are crowded together, and on this account the forests composed almost wholly of oaks have no resemblance to park-like oak forests of the North. Their tops are so remote overhead that it is seldom realized one

is walking under oak trees, unless reminded by acorns on the ground.

Many trees of other groups are associated with the oaks, and sometimes in even greater numbers. Among the commoner ones are *Lauraceae* of the genera *Nectandra, Ocotea,* and *Persea; Cedrela, Sapium, Chaetoptelea, Talauma, Xanthoxylum, Podocarpus, Engelhardtia,* the endemic genus *Alfaroa* (*Juglandaceae*); *Ladenbergia,* a relative of *Cinchona,* and only here in North America is found, in limited stands near San Ramón, a true *Cinchona, C. pubescens.* Among the common genera of small trees and shrubs are *Croton, Montanoa, Myrcia* and *Eugenia, Hedyosmum, Geonoma* and other genera of palms, *Malvaviscus, Robinsonella, Panopsis, Litsea, Arctostaphylos, Conostegia, Hauya, Trichilia* and *Guarea, Roupala, Symplocos, Cestrum,* and *Rondeletia.* There are many shrubby *Compositae* and *Myrsinaceae,* and other groups well represented are *Gesneriaceae, Rubus, Paullinia* and *Serjania, Palicourea, Siparuna,* and *Mollinedia.* Characteristic herbaceous plants are *Begonia, Passiflora, Lamourouxia, Salvia, Desmodium, Ipomoea, Geranium,* vast numbers of ferns including tree ferns and many epiphytes, *Gynandropsis, Heliconia, Loasa,* and numerous small melastomes. Interesting aquatic plants are the small *Podostemonaceae* of swift streams.

Exceedingly beautiful are the pasture lands and roadsides during the rainy season when there are wide displays of varied color, produced by low plants that are essentially weedy. Most conspicuous of these is the *Santa Lucía, Alomia microearpa,* similar to garden *Ageratum,* that completely covers hundreds of acres of pasture land. Another garden plant that abounds as a weed in cornfields, just as sunflowers (*Helianthus*) do in the United States, is the dahlia, *Dahlia rosea.*

*Cold region* (*tierra fría*).—The reputation of Costa Rica's flora for beauty and variety is based largely upon the vegetation of the *tierra fría,* and any account of this is difficult because of the complexity of the task and the wealth of the material to be considered. A botanist with only a short time to spend in Costa Rica should devote it to this belt, where he will be amazed at the exuberant vegetation. It is improbable that any part of the American continent except the somewhat similar mountains of Colombia and Ecuador can compete with Costa Rica in the richness of this flora.

The *tierra fría* comprises all mountain slopes above about 1,500 meters, but this belt must be subdivided into a lower one of considerable extent, and a very small one, the *tierra fría* as limited by PITTIER. The *tierra fría* proper, or cold region, is an area of dense saturated forest of medium-sized trees. Their tops are drenched every night of the year with drizzling rain or heavy downpours, and most of the time they are shrouded in fog and drifting clouds. Every branch is swathed in a dripping-wet covering of mosses, hepatics, and other epiphytes. There is no dry soil, and all the vegetation is like a saturated sponge. Agriculturally this is the region of potato cultivation and dairying. The climate is really cold, and there is nothing to remind one of lowland tropics. Many of the plants are local in distribution, some of them known from a single ravine. The floras of canyons but a few miles apart along the slopes of the high volcanoes often differ amazingly, some of the most conspicuous plants abundant in one canyon being absent in another otherwise similar one only three or four miles away.

Most of the *tierra fría,* unless modified by man, is invested with very dense forest of trees of varying size of diverse families and genera. The genus best represented by species and individuals is *Quercus,* and oaks are dominant over large areas of the upper mountains. Other characteristic genera or species are *Podocarpus, Weinmannia, Blakea, Topobea, Prunus, Morus insignis, Magnolia* and *Talauma, Oreopanax, Hedyosmum, Eugenia,* and *Myrcia, Drimys, Phyllonoma, Brunellia, Sambucus, Psychotria, Hydrangea, Ilex, Solandra, Billia,* and *Clusia,* Luxuriantly represented are *Gesneriaceae, Lobeliaceae,* and *Ericaceae,* many with brilliant flowers in shades of red.

The wet forests of the *tierra fría* are *par excellence* the region of epiphytes, and here are found the majority of Costa Rica's many hundreds of orchids, in unbelievable numbers of individuals, with many species associated upon a single tree no larger than an apple tree. Here abound bromeliads, and the number of fern genera and species is fantastic. The upper slopes of the Volcán de Turrialba perhaps hold a world record for the number of fern species growing in a limited area.

Great parts of the *tierra fría* have been cleared for cattle pastures. After the trees were felled, the land was sown with grass seed, usually of European origin, and as a result the pasture flora is more European than American. The forage grasses are European, and with them are naturalized European plants like *Trifolium repens, Lotus, Bellis perennis, Silene gallica, Ranunculus, Veronica, Taraxacum, Digitalis,* and many more.

A very specialized flora is confined to low thickets at timber line on the high volcanoes and at the edges of the paramo districts to be mentioned later. Shrubs or small trees restricted to such places are species of *Escallonia, Ribes, Berberis, Mahonia, Hesperomeles, Holdodiscus, Myrtus, Pernettia, Buddleia alpina, Arcytophyllum,* and a few *Senecios.* Giant herbs are *Myrrhidendron* and a species of *Rumex* sometimes six meters high.

Perhaps the most interesting and distinctive phytogeographic region of Costa Rica consists of the very limited paramos or paramillos found only in the high mountains toward Panama, and best developed upon Chirripó, Cerro de la Muerte, and nearby Cerro de las Vueltas. They are the only North American areas whose flora is similar to those of the extensive paramos of the South America Andes, with the possible exception of alpine areas in western Guatemala, whose paramo species are almost lost among boreal elements. Here in Costa Rica is the northern limit of the genera *Puya* and *Greigia,* and of many species or species groups of such genera as *Eriocaulon,* cycad-like *Lomarias, Lycopodium, Alchemilla, Acaena, Hypericum, Geranium,* and *Eryngium.* There is every indication that these isolated islets of plants, now so small, will soon be occupied by encroaching forest, which reduces them relentlessly to shallow sphagnum-filled pools.

An enumeration of the known phanerogams of Costa Rica with more detailed discussion

of their general and local distribution is found in PAUL C. STANDLEY, *Flora of Costa Rica*, Botanical Series, Field Museum of Natural History, volume 18 (1937-38). On page 62 of that volume is a brief bibliography of publications treating the vegetation of the country.

The larger or more important families of Costa Rican phanerogams include the following: *Gramineae*, 283 species; *Palmae*, 28 genera and 92 species; *Bromeliaceae*, 153 species; *Orchidaceae*, 122 genera, 955 species; *Piperaceae*, 537 species; *Leguminosae*, 325; *Euphorbiaceae*, 112; *Melastomaceae*, 213; *Ericaceae*, 50; *Solanaceae*, 129; *Gesneriaceae*, 99; *Rubiaceae*, 251; *Compositae*, 300.

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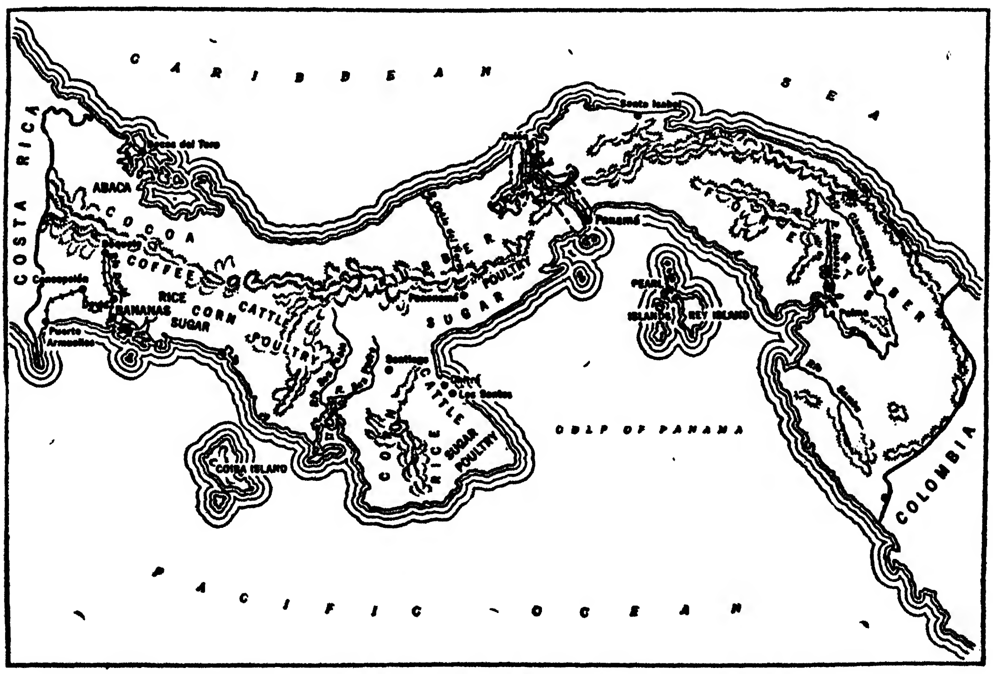
WALTER R. LINDSAY: **Plant Resources of the Panamas:** — The Republic of Panama, with the Canal Zone, forms the connecting link between North and South America. Panama is bounded on the north by the Caribbean Sea, on the east by Colombia, on the south by the Pacific Ocean and on the west by Costa Rica. Its area is 32,380 square miles and its population is about 632,000. Two mountain ranges traverse the whole country enclosing a number of valleys and plains with excellent pasturage for cattle. There are extensive forests on the slopes of the mountains and numerous banana plantations along the Atlantic coast.

the most important of which are corbina, sailfish, tarpon, red snapper and mackerel. Several rivers in the Chiriqui province have been stocked with trout. Wild game is plentiful in the forests; this includes deer, tapir, wild pigs, monkeys, wild cats, agouties, ant eaters, rabbits, racoons and many others. Alligators abound in the creeks of the coast and ducks and other migratory birds and pigeons are common in the forests.

Over fifty species of commercially valuable timber trees are found. These include such well known woods as mahogany, cocobolo, guayacan, nispero, etc. Castilloa rubber trees are common in many provinces.

Large manganese deposits are located in the San Blas Gulf, in the Boqueron Valley and in the Province of Veraguas. Gold, aluminum, iron and asbestos have also been found.

Cattle raising for beef is undoubtedly the largest branch of the agriculture of the country and is by far the greatest source of revenue. Roughly 90% of the utilized acreage of the country or approximately 5,000,000 acres is used up in pastures. The stock of cattle with some very few exceptions is decidedly poor and the present Government cattle breeding program will be of inestimable value. Practically all of the meat produced is consumed in the country and very little is available for the needs of the Canal Zone which has to import large quantities of meat from the United States, Cuba, Colombia and at present, from the Argentine.




AGRICULTURAL REGIONS OF THE ISTHMUS OF PANAMA (Courtesy of *Agriculture in the Americas*).

All of Panama is in the Tropics and the coastal interior lowlands are hot and humid. The annual average temperature is about 80° F. with little seasonal variation; that high up in the mountains is 66° F. The Atlantic coast receives about 140 inches of rain a year, the Pacific 60, and the interior 90 inches, most of the fall coming during the rainy season from May through December.

The waters around Panama teem with fish,

The dairy branch of the livestock industry is more efficiently developed but has confined itself principally to the production and distribution of fresh milk to the cities and towns of the Republic. The country still imports over half a million dollars worth of dairy products in the form of butter, cheese and milk in various forms.

The second largest agricultural industry in Panama is the growing of sugarcane for the

manufacture of sugar and alcohol. Six fairly large factories manufacture most of the sugar and alcohol while the panela and crude syrup is made bv the small farmers. Almost 50% of the cane used by the large factories is grown by small farmers. The sugar recovery from the cane is low partly due to factory inefficiency but primarily from the low sugar content of the cane which is invariably harvested green. Panama has never been an exporter of sugar and it is not likely to be on account of the high cost of production. Were it not for the Government protection and the large returns from the sale of alcohol it is probable that there would be a sharp decline in sugar production.

Bananas, cacao and coffee are the only crops grown for export. The banana industry is best organized in the Chiriqui Province where it is in the hands of the United Fruit Co. The spread of a banana disease, "sigatoka" (*Fusarium cubense*) makes it necessary to abandon certain areas and to move on to new ones. There are considerable areas of banana lands adjacent to the present districts of Santo Domingo and Concepción which are the smaller farmers' centers for banana production. Other areas in Panama which are suitable for banana production are just outside of the rainfall belt and so could not be used successfully without providing irrigation during the dry season. The banana production in the Bocas del Toro Province is a dying industry due to the Panama disease. However, the United Fruit Company has been growing cacao, and more recently, abaca (*Musa textilis*) on these abandoned banana areas. The only cacao grown for export in Panama comes from this region and it may not be long before the production of abaca and manilla hemp reaches noteworthy proportions.

Tobacco, rice, corn and many fruits and vegetables are easily grown in various parts of Panama and their production is being encouraged.

Practically all of the truck gardens are found adjacent to the cities of Panamá and Colón and are run by most efficient Chinese gardeners. The products are either sold in the local markets or are peddled from house to house. Small-sized tomatoes, a loose-leaf variety of lettuce, okra, cucumbers, radishes, small onions, peppers, beans, chayotes and a variety of tropical vegetables are grown in these little gardens. During the dry months the gardens are watered by hand. Some vegetables which do not do well in the wet season produce fairly well in the dry season. Tomatoes and cabbages are classic examples.

The opportunity for marketing almost any crop one would choose to grow in Panama is excellent as the population of the Canal Zone, including the Army, Navy and civilians, would take it all. At the present time practically all foods are imported from the United States, Argentina, Colombia and Cuba.

The Department of Agriculture in Panama has recently established a demonstration and experimental farm at Divisa in the Province of Los Santos. This farm is situated on the rich alluvial plateau formed by the Santa Maria River and is amply supplied with water from this river. The results of this farm should be far reaching.

In 1923 the Governor of the Canal Zone established an Introduction Gardens (later changed to the Experiment Gardens) at Summit, Canal Zone, for the purpose of introducing and disseminating desirable plant material to farmers in the Canal Zone. The Gardens have grown until they now cover approximately 250 acres and have introductions running upwards of 13,000. Thousands of improved or selected economic and ornamental plants are disseminated from these Gardens each year to customers in neighboring countries such as Panama, Colombia, Costa Rica, El Salvador and Honduras.

CANAL ZONE EXPERIMENT STATION,
SUMMIT, PANAMA (CANAL ZONE).

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J. P. CARABIA: **A Brief Review of the Cuban Flora:** — Cuba, the largest island in the West Indies, is neither of oceanic nor volcanic origin, but is a portion of the ancient northern part of the South American continent. For this reason, its flora bears a very strong resemblance to those of the larger islands of the Caribbean of the same origin, as well as to northern South America. The Cuban vegetation also shows an affinity to Central American vegetation as well as to that of the southeastern United States and the Bahama Islands.

Cuba is the most northern island of all the West Indies, with exception of a few Bahama islands, and has quite an agreeable climate. The annual temperature oscillates between 60° F. and 80° F. There are only two seasons, summer and winter. In the first season, the temperature averages from 75° to 80°, and in winter from 60° to 75°. The two seasons mentioned, summer and winter, are known also as the wet and dry seasons; the west season being from May to October and the dry from November to April. The average rainfall is about 45 to 65 inches a year.

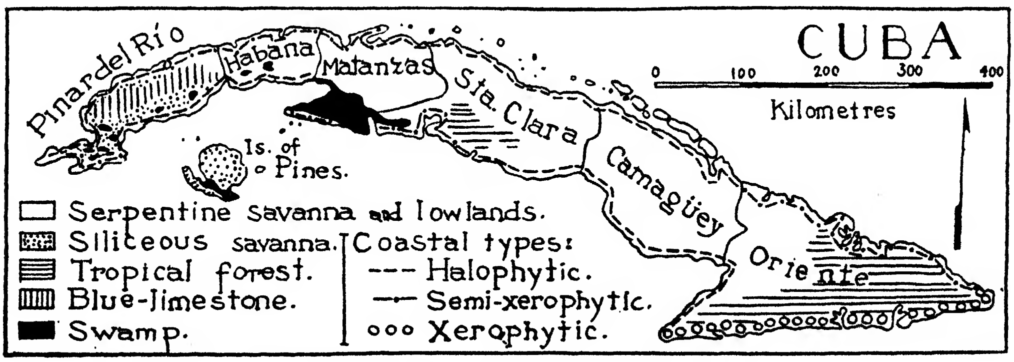
The flora of Cuba is rich, containing nearly 8000 known species of vascular plants with a very high percentage of endemism. The number of species in some of the larger and often conspicuous families is as follows: *Gramineae* 369, *Compositae* 325, *Rubiaceae* 296, *Orchidaceae* 270, *Euphorbiaceae* 256, *Cyperaceae* 210, *Melastomataceae* 156, *Papilionaceae* 154, *Myrtaceae* 150, *Malvaceae* 96, *Palmae* 88, *Bignoniaceae* 86, *Verbenaceae* 84, *Convolvulaceae* 85, *Boraginaceae* 82, *Solanaceae* 75, *Apocynaceae* 75, *Urticaceae* 74, *Caesalpiniaceae* 73, *Asclepiadaceae* 65, *Bromeliaceae* 60, *Acanthaceae* 54, *Malpighiaceae* 53, *Cactaceae* 53, *Labiatae* 52, *Gesneriaceae* 47, *Mimosaceae* 45, *Piperaceae* 42, *Rutaceae* 39, *Polygonaceae* 39, *Amaranthaceae* 37, *Sapotaceae* 37, *Loranthaceae* 36, *Flacourtiaceae* 36, *Amaryllidaceae* 33, *Rhamnaceae* 32, *Sapindaceae* 32, *Polygalaceae* 30, *Sterculiaceae* 28, *Moraceae* 27, *Myrsinaceae* 25, *Anonaceae* 20, *Capparidaceae* 19, *Theophrastaceae* 17, *Araceae* 15, *Simarubaceae* 14, *Anacardiaceae* 13, *Burseraceae* 12, *Combretaceae* 11, *Meliaceae* 10, *Pinaceae* 4, *Bombacaceae* 4, *Cycadaceae* 4, *Rhizophoraceae* 1, and *Fagaceae* 1.

The island has six major floristic groups: 1) coastal and shore vegetation, 2) savannas, 3) tropical forest of Oriente and Santa Clara hills, 4) blue limestone hills of Pinar del Río, 5) swamp and lagoon vegetation, and 6) the siliceous savannas of Pinar del Río and Isle of Pines.

1) Cuba has a very irregular coastline and is surrounded by innumerable small islands or cays. As a consequence, it has an unusually abundant coastal vegetation which may be divided into three general types: xerophytic, semi-xerophytic, and halophytic. The most extensive type of coastal vegetation is the halophytic, in which *Rhizophora mangle, Laguncularia racemosa, Conocarpus erecta,* and *Avicennia nitida* are predominant. Under those trees, frequently we find a group of herbaceous plants such as *Batis maritima, Philoxerus vermicularis, Trianthema portulacastrum, Stemodia maritima,* and *Baccharis angustior,* and a group of grasses and sedges such as *Distichlis spicata, Uniola paniculata, Cyperus brunneus,* and *Fimbristylis glomerata.* When the shore is higher, a psammophilous formation takes the place of the preceding group, characterized by *Tournefortia gnaphalodes, Rhachicallis americana, Suriana maritima, Borrichia arborescens, Strumpfia maritima,* and the pantropical *Ipomoea pes-caprae.* This last group of plants, in general, is surrounded by a group of higher plants such as *Coccoloba uvifera, Chrysobalanus icaco,* and *Capparis* spp. Another type of coastal vegetation is the semi-xerophytic, occurring where coral reefs and limestone deposits are exposed. Here a great number of shrubs such as *Caesalpinia bahamensis, C. pauciflora, Pithecolobium hystrix, Caesalpinia coriaria, Coccothrinax litoralis,* and *Plumeria obtusa* are common. Among these, various species of *Eugenia, Agave, Metopium, Croton,* and *Comocladia* and the poisonous *Hippomane mancinella* are frequently found. With these plants we may see a group of creeping plants like *Smilax havanensis, Pisonia aculeata,* and *Batocydia ungis,* all of which form an almost impenetrable thicket. In some localities, and especially near Havana, we may find on the same rocky shore a group of small and succulent plants, under the constant influence of the salt water. Among these are *Trianthema portulacastrum, Suaeda linearis,* and *Philoxerus vermicularis;* also here we find creeping forms of *Conocarpus erecta* and *Borrichia arborescens* which do not reach above an inch over the rocks. On the south coast of Oriente we find the best type of xerophytic vegetation in Cuba. Here are frequently seen a group of microphyllous shrubs such as *Erythroxylon brevipes, E. minutifolium, Catesbaea holacantha, Maytenus buxifolia,* and *Ehretia tinifolia.* Among these plants, large colonies of *Cactaceae* are conspicuous, *i.e., Cephalocereus brooksianus, Lemaireocereus hystrix, Dendrocereus nudiflorus, Opuntia dillenii, O. macracantha, Harrisia fernowi,* and *Leptocereus sylvestris.*

2) Much of Cuba consists of land of low relief, and the casual traveler sees little else than the cultivated fields of sugar cane and tobacco plantations, which, when abandoned, fall prey to an introduced shrub, *Dichrostachys nutans.* However a portion of these lowland areas has been little disturbed and supports specialized types of vegetation, which we will refer to as savanna, because the most widespread type is the serpentine savanna. Stretching from Havana to Oriente, these savannas are covered by different associations. On the pure serpentine savanna one usually finds a group of plants represented by *Belairia mucronata, Brya ebenus, Randia spinifex, Reynosia mucronata, Rheedia aristata, Leucroton flavicans, Guettarda holocarpa,* and *Croton sagraeanus.* On the better savanna lands, these groups of shrubs are replaced by a group of grasses and sedges, and the arboreal element is represented by large colonies of palms, such as *Sabal florida, Copernicia torreana, C. hospita, C. baileyana,* and *Coccothrinax miraguama.* From this type of savanna we pass to the type with the best soil—the prados, which, being rich in grass, are dedicated to the pasturing of cattle. Here grasses of the genera *Panicum, Paspalum, Arundinella,* and *Arthrostylidium* are common. Other grasses cultivated there are *Panicum maximum* and *P. purpurascens.* The typical trees on these savannas, or prados, are *Roystonea regia, Samanea saman, Guazuma tomentosa, Ceiba pentandra, Crescentia cujete, Chlorophora tinctoria, Cecropia peltata, Gliricidia sepium,* and *Bursera simaruba.* In many cases the last mentioned group of plants may represent the remnants of the lowland forest of Cuba, which have been cleared out for pasturing or agricultural purposes.

3) The mountains of Oriente and Santa Clara are mainly composed of granite and other igneous rocks surrounded by a lower frame of limestone, giving rise to various types of soils, which enrich the flora. The vegetation of these hills is the typical complex flora of the tropics,




THE VEGETATION OF CUBA (*Original*).

and on the highest elevation, where the mountains comb sufficient water out of the trade winds, we find the complex montane tropical forest. These hills, with less than 1000 m. altitude, support a large number of woody plants, such as *Dipholis jubilla, Calophyllum antillanum, Oxandra lanceolata, Clusia rosea, Faramea occidentalis, Cecropia peltata, Didymopanax morototoni, Prunus occidentalis, Hyperbaena cubensis, Dendropanax arborea, Prockia crucis, Juglans insularis, Celtis trinervia, Cedrela odorata, Ochroma lagopus, Hibiscus tiliacea, Exostemma sanctae-luciae, Mouriria monantha, Swietenia mahagoni, Pseudocarpidium wrightii, Zanthoxylum spinifex,* and *Chuncoa chicharronia.* Frequently on the summits of these hills large colonies of *Pinus cubensis* and scattered groups of *Juniperus barbadensis, J. saxicola, Pinus occidentalis, Bactris cubensis,* and *Podocarpus* spp. predominate. Above 1000 m. one finds the wet tropical forest, with trees covered by a host of mosses, hepatics, and inconspicuous orchids. Here also *Viburnum cubense, Oxandra lanceolata, Carapa guianensis, Hymenaea courbaril, Faramea occidentalis, Garrya fadyenii, Schaefferia frutescens, Myrica cacuminis, Chimarrhis cymosa, Torralbasia cuneifolia, Cyrilla racemiflora, Homalium racemosa, Euterpe globosa, Magnolia cubensis, Freziera grisebachii, Clethra cubensis, Weinmannia pinnata, Elaeagia cubensis,* and *Rubus turquinensis* occur, as well as several species of *Persea, Miconia,* and *Ocotea.* Some species of *Cyathea* and *Alsophila* and the interesting *Equisetum giganteum* overtop a large number of other pteridophytes. Several species of *Bromeliaceae, Begoniaceae,* and *Araceae* complete the picture.

4) The Sierra de los Organos of Pinar del Río is formed by blue limestone hills of the Lower Cretaceous. These hills, named "mogotes," are isolated eroded remnants, generally with steep, nearly perpendicular side-forming cliffs; they are scenically interesting because of their peculiar shape. The flora of the mogotes includes a remarkable number of endemic species. Among the widespread species on the mogotes are *Bombax emarginatum, Erythrina cubensis, Gaussia princeps, Thrinax punctulata, Omphalea hypoleuca, Ekmanianthe actinophylla,* and *Spathelia brittonii.* Here also species of *Anthurium, Agave, Peperomia, Pilea, Tillandsia, Hohenbergia, Vriesia,* and *Catopsis* cover the perpendicular cliffs.

5) The swamp type of vegetation is well developed in the southern part of Santa Clara, Isle of Pines, Pinar del Río, and Havana. Here we find the interesting *Salix occidentalis* and the quite rare *Fraxinus cubensis,* also *Cephalanthus occidentalis* and *Typha domingensis* are common. On the water we may see *Castalia odorata, Nymphaea advena, Eichhornia crassipes,* and *Pistia stratiotes.* Also we should mention the vegetation along brooks and rivers. Here two plants are most conspicuous, one a palm, *Calyptronoma dulcis,* and the other an introduced plant, *Eugenia jambos.* Many other trees of the neighboring associations may be found here, such as *Roystonea regia, Psidium guajaba, Bucida buceras, Cecropia peltata,* and *Didymopanax morototoni.*

6) The last region to be mentioned is the siliceous savanna of Pinar del Río and Isle of Pines. Those two areas have a well known and most endemic flora. However, some of the principal trees are the widespread *Pinus caribaea, Quercus virginiana, Acoelorhaphe wrightii, Curatella americana,* and *Byrsonima crassifolia.* Among the endemics are *Pinus tropicalis, Vaccinium cubense, Befaria cubensis, Rondeletia correifolia, Hypericum styphelioides, Kalmiella aggregata, Tabebuia lepidophylla, Pieris cubensis, Xolisma myrtilloides, Coccoloba colomensis,* and various species of *Xyris, Polygala, Burmannia, Pinguicula,* and *Eriocaulaceae.* Here also we find the rare cycad *Microcycas calocoma.*

*Botanical Explorations in Cuba.* — A very brief mention of the first plants that Columbus saw in Cuba is found in his diary dated 1492. Years later, in 1535, Oviedo mentions a few plants from Cuba in his "Historia Natural de las Indias." However, no botanical exploration was made until W. Houstoun came to Cuba in 1729, remaining until 1753. From 1748 to 1752, F. W. Nascher was collecting in the vicinity of Havana. Since that time many botanists have collected in this island. Among the most notable we should mention N. J. Jacquin (1758), O. Swartz (1784), A. Humboldt and A. Bonpland (1800-1801, 1804), and J. Linden (1837-1838, 1844). Among these botanical explorations there were some of importance, but C. Wright was the first to make a really intensive botanical exploration of this island. Wright remained in Cuba from 1856 to 1867, with a few absences for trips to the United States. Another chapter of the botanical exploration in Cuba was started in the twentieth century with the explorations of N. L. Britton and a group of assistants: J. A. Shafer, P. Wilson, and Frère León. The last and most important exploration in this century was the one made by E. Ekman, who remained in Cuba from 1914-1924. By means of his explorations, Ekman was able to make a great contribution to the publication of the "Symbolae Antillanae" by I. Urban.

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Juan T. Roig and J. Acuña: **Plant Resources of Cuba:** — Cuba is situated between the 19th and 23rd degrees N. and between the 74th and the 84th degrees W. of Greenwich. The great importance of its geographical situation was recognized from the time of the conquest, when the Island was spoken of as "la llave del Golfo Mejicano y Antemural de las Indias" (the key to the Gulf of Mexico and the Front Wall of the Indies). Due to its long and narrow form, Cuba has an essentially maritime climate; the breezes from the Atlantic Ocean and the Caribbean Sea alternately cool the atmosphere, resulting in one of the mildest climates in the world. These favorable conditions, together with its nearness to the United States, its beautiful landscapes, and its excellent thermal baths, make Cuba exceptionally attractive as a tourist resort. Increasing rapidly in importance

in this regard, the tourist trade already constitutes an important source of revenue. Situated near the Tropic of Cancer, and having soils of various types, Cuba can produce all kinds of tropical crops, as well as a considerable number of those of subtropical origin. Owing to its small merchant marine, its economy rests mostly on agriculture, on cattle raising, on mining, and on fishing. Of all these resources, agriculture and the derived industries are the fountains of the greatest income. From these sources only Cuba has been able to put into circulation about 1000 million dollars a year.

Among the principal plant products are sugar, tobacco, coffee, tropical fruits, vegetables, fibers, and forest products.

*Sugar cane.* — The most important product of Cuba is cane sugar, on which the prosperity of the country depends almost entirely. In 1925 the crop amounted to 5,189,386 long tons of sugar, valued at $260,380,830; but the highest prices were obtained in 1920, the production being only 3,785,425 tons, which sold, however, for $999,899,458. The Cuban quota for the present year is 2,458,769 tons. The national consumption is about 250,000 tons, that is, 120 lb. per capita. The Cuban quota for 1944 is 4,836,000 short tons.

Sugar cane is extensively cultivated in the six Cuban provinces, but the largest plantations and the largest sugar mills are in Oriente, Camagüey, and Santa Clara Provinces. The most popular cane variety is P.O.J. 2878, which represents 60% of the crop. The propagation of this variety has greatly contributed to the increase of yield and to the elimination of the mosaic disease. The Cuban Department of Agriculture is working on the production of immune varieties. Through the Central Experiment Station at Santiago de las Vegas, an experiment station for sugar cane alone has also been created recently; this will be located at Central Limones, in Matanzas Province. In 1938 the total amount of raw sugar, refined sugar, and inverted syrups exported was valued at $11,323,441.

Several large distilleries for the production of alcohol and several large rum factories are in operation in Cuba; these plants utilize large quantities of molasses and syrup.

*Tobacco.* — The second Cuban plant product is tobacco, which has for ages been considered as the best of the world. In Havana and other cities of the western portion of the Island there were in operation many large cigar and cigarette factories that gave employment to many thousands of workers, but for the past 50 years both the cultivation and the manufacture of tobacco have been decreasing constantly, on account of prohibitive taxes and of the falsification of Cuban cigars which is being practised in almost every country, and also on account of the change in the taste of the smokers, who now prefer cigarettes of the Egyptian type to pure cigars.

Formerly tobacco was cultivated only in Pinar del Río and Havana Provinces, but at present it is grown in all provinces except Matanzas. According to the quality and origin, the Cuban tobacco types are classified as follows: Vueltabajo, the tobacco grown between the Hondo and Cuyaguateje Rivers, in Pinar del Río; Semivuelta grown from west of Hondo River to the limit of Havana province; Partido, grown in Havana Province; Remedios grown in Santa Clara Province, and Vueltarriba, grown in the two eastern provinces. The Vueltabajo type is considered the best and it is characterized by the fine aroma, elasticity, and beautiful colors; that from Remedios is characterized by its excellent burning qualities and white ashes; and that known as Partido is used only for wrappers and is esteemed for the light colors and fine texture. During the last 20 years the value of tobacco exported has decreased rapidly from a maximum of $48,705,259 in 1920 to a minimum of $12,198,722 in 1940. The local consumption in 1940 was estimated at $26,464,322.

*Coffee and Cocoa.* — Just after the revolution and independence of Haití the cultivation of coffee became the most important crop of Cuba; but later, owing to the low prices, to the development of the sugar cane industry, but chiefly as a result of the expulsion of the French colonists, who had established the best and largest coffee plantations, the cultivation of this plant was almost totally abandoned, and for many years it was necessary to import coffee from Puerto Rico and Central America. With Government aid the production again increased, and now Cuba is able to supply its own market and to export considerable amounts of coffee to the United States. The crop of greatest value exported in recent years was that of 1934, amounting to 13,936,700 pounds, which were sold for $1,205,975. The largest exportation, however, was in 1939 with 18,205,400 pounds, but this amount brought only $856,004.

The largest crop was also that of 1939, when no less than 71,159,600 pounds were produced. Coffee is grown in Cuba only in the mountainous regions of Oriente, Santa Clara, and Pinar del Río Provinces. An experiment station for coffee has recently been established at Palma Soriano, Oriente Province, to render technical assistance to the coffee planters. The Instituto Nacional del Café controls the production, the prices, and the wages of the workers. The domestic consumption of coffee is from 40 to 43 thousand pounds monthly.

Cocoa is grown in Oriente Province on a small scale. In 1939, the exportation was 135,402 kg., sold for $30,264. This crop, which has been slowly emigrating from America, is being studied by the Cuban Government in order to further its development.

*Fruits.* — Many tropical fruits are grown in Cuba for local consumption and also for preserving. Those exported in considerable amounts are pineapples, bananas, avocadoes, and citrus, chiefly grapefruit.

During the last century the exportation of bananas from the northern districts of Oriente Province was very important, but the plantations have been constantly declining, due chiefly to the "Sigatoka" disease and to a lesser extent to the "Panamá" disease. In the 1937-1938 crop eight million bunches of bananas were exported, while in 1940 the exportation amounted to less than 4 million. The Central Experiment Station at Santiago de las Vegas is now endeavoring to breed banana varieties which are immune or highly resistant to those diseases.

Pineapples are extensively cultivated in Havana and Pinar del Río Provinces, and more recently in western Camagüey Province also, but to a lesser extent. The exportation of this fruit to the United States in 1938 amount to $850,361.

Large quantities of preserved pineapples are also exported.

The avocado is grown throughout the Island, there being a number of very fine varieties, but the commercial plantations are limited to Havana and Pinar del Río Provinces. The production of this fruit has been extended to cover almost the whole year, although the regular crop is from June to October. The avocadoes shipped to the United States in 1938 were valued at $120,250. The local consumption is very large, this fruit appearing daily on the tables of most Cubans during the summer months.

The cultivation of citrus fruits had a great development during the early years of the Republic, when many large orange groves were established in Pinar del Río, Havana, and Camagüey Provinces. A number of these groves had to be abandoned later on account of being situated on poor soils, while other plantations were seriously attacked by the "black fly." This pest was later controlled by the introduction from the Far East of the chalcid parasite, *Eretmoserus serius*, a project carried out by the Cuban Government in coöperation with the U. S. Department of Agriculture.

Oranges can now be obtained in the local market throughout the year. The exportation of oranges, grapefruits, and mandarin oranges in 1938 was valued at $89,000.

During the last five years the cultivation of papaws for home consumption and for export has greatly increased. One grower alone exported as much as 30,000 pounds weekly. Unfortunately the papaya plantations are seriously menaced by a virus disease which has not yet been controlled. A good many tropical fruits are grown in Cuba for local consumption such as: mangoes of several varieties, the red mamey, sapodilla, sour sop, sugar apple, sweet sop, yellow mammea, star apple, guava, cashew nut, canistel, hicaco, and tamarind. These fruits and also papaws and pineapples are used in making sorbets, cold beverages, and also preserves which are prepared in several large factories. The total exportation of fruits during 1940 was $5,841,442, and that of preserved fruits was $606,504 in 1938.

*Vegetables.* — The cultivation of vegetables for export during the winter partially solved the problem of unemployment in the western provinces. During these months large amounts of tomatoes, egg plants, cucumbers, beans, and okra are shipped to the United States. In 1938 the vegetable products exported amounted to $8,863,042.

In Cuba all food crops grown only for home consumption are called small crops. Corn, rice, edible roots or tubers, and some salt meat or pork constitute the daily food of the laborers. The most important small crops are plantains, sweet potatoes, taros, cassava, yams, Irish potatoes, squashes, beans and greens.

The production of cassava is particularly important for the manufacture of starch, cassava bread, and tapioca. Many factories for the extraction of starch now operate in Cuba, but these are primitive and the product is of low quality; some of the plants, however, have been remodelled along modern lines and are producing tapioca flour of high quality for export to the United States, to supply the demand for this commodity formerly obtained from the Dutch East Indies. During the winter months and early spring, Irish potatoes are grown for the local market and for export, but at other seasons of the year large amounts are imported from the United States and Canada.

*Cereals.* — The only cereals grown are corn, rice, and grain sorghum. Cuban corn is very nutritious and is grown throughout the Island largely for converting into meal, which is one of the favorite dishes of poorer people. Two crops a year are obtained in Cuba, known as "maíz de agua" and "maíz de frio." However, the production is not sufficient to supply the demand and it is sometimes necessary to import corn from the United States and from Argentina. Rice is a regular dish on the table of all Cubans, and although the Cuban product is of excellent quality, large amounts are still imported from Asia and the United States. The Cuban Government is encouraging this crop by the distribution of selected seeds and of rice mills. Rice is grown in the six provinces, although large plantations are found only in Havana, Pinar del Río, and Santa Clara Provinces. The crop for 1941 is estimated at 100 million pounds, scarcely one-fifth of the local consumption, which is over 500 million pounds a year.

Grain sorghum is also cultivated on a small scale for poultry feeding.

*Oil plants.* — During the past few years the cultivation of peanuts for oil has been developed on a large scale. This has partially solved the problem of the "tiempo muerto" (dead season) in the sugar cane districts. The Cuban Government has stimulated the cultivation of peanuts by the distribution of selected seed and by supplying technical assistance when needed. There are four large plants in Cuba for the extraction of peanut oil; a part of this oil is exported and the local consumption is increasing daily. The actual production is estimated at 100 million pounds and the total yield at 20,000,000 pounds of oil. From their crop the growers receive about $2,500,000 a year.

Other oleaginous plants of less importance produced in Cuba are castor-oil, sesame, sunflower, and several palms.

There are over 1,500 acres of castor-oil plants in Oriente Province and several small mills extract the oil for home consumption. The cultivation of coconuts for oil was formerly a very important business in the Province of Oriente, but it declined greatly as a result of the destruction of many coconut groves by the budrot disease. While there are some coconut groves scattered throughout the Island, these are small and at present the coconuts are chiefly used while green for their water, which constitutes a refreshing and diuretic drink, although considerable quantities of dried coconuts are used in the manufacture of ices, candies, and preserves.

Formerly sesame and sunflower were also cultivated on a commercial scale for their oils, but the use of these has been discontinued; this is also true of the oil of two wild native palms, the corojo (*Acrocomia armentalis*), and the Royal palm (*Roystonea regia*). The cultivation of the tung-oil tree and of the African oil palm (*Elaeis guineensis*) is being encouraged by the Government.

*Textiles.* — The only textile plant grown in Cuba on a large scale is Henequén or sisal, from which the raw material for the large rope factory at Matanzas City is obtained. There are extensive henequén plantations around that city; smaller ones and also machines for extracting the fiber are located at Mariel, Cárdenas, Nuevitas, and Media Luna. The value of

the rope exported in 1938 was $1,056,892. The recent improvement in the henequén industry of Cuba may be a result of the decline of the Yucatán plantations during the past few years.

Two native plants, malva blanca (*Urena lobata*) and Guasimilla (*Helicteres guazumaefolia*), are used on a small scale. About ten tons of these fibers are employed in the manufacture of alpargatas, a kind of sandals, an industry located at Guanabacoa, near Havana.

Considerable quantities of cheap ropes are made from the fibers of majagua tree (*Pariti tiliaceum*) and from the leaves of the Yuraguana (*Thrinax miraguana*), a native palm. Hats for the peasants are made of yarey (*Copernicia textilis*), while from the leaves of corojo (*Acrocomia armentalis*) very fine dusters and very strong fishing lines are manufactured.

The cultivation of Ramié or China grass is now being developed and a plant for removing the fiber is being constructed at Rancho Veloz, Santa Clara Province. This fiber will be used in the manufacture of cigarette paper.

The Cuban Government is encouraging silkworm culture and has established an Estación Sericícola, and several white mulberry plantations of several varieties have been set out.

*Forage plants.* — For many years after its colonization, Cuba was essentially a cattle country. However, the livestock was almost totally destroyed during the wars for independence. Later, the Republic established, it became necessary to import cattle from Mexico and other countries. Large amounts of butter, cheese, and condensed milk were also imported. With official aid, the cattle business again flourished and has become the second in importance of the industries of Cuba, with more than six million heads of cattle. Butter and other milk products are now manufactured in Cuba for the domestic market, while large amounts of butter and frozen meat are exported. Cuba has over 13 million acres in pastures to support its livestock; some of these are composed of native grasses and leguminous plants, but there are also many artificial pastures in which Guinea grass and Para grass are grown. The following native grasses are also used for forage: yerba de cepa (*Paspalum plicatulum*), Cambute (*Paspalum notatum*), and three introduced Andropogons: Pitilla americana (*Andropogon annulatus*), Camagüeyana (*Andropogon pertusus*), and Jiribilla (*Andropogon caricosus*). The tops of sugar cane or cogollo are also used for feeding oxen in the sugar cane districts.

*Forest products.* — At the time of its discovery, Cuba was covered with dense forests with many hard woods, suitable for rural constructions, carpentry, and cabinet work. During the past century the principal income of the landowners was derived from their forests, but, owing to excessive cutting, which reached a maximum just after the central railroad was built and later during the period of great prosperity in the sugar cane industry, heavy forests remain only in the most inaccessible localities of the high mountains.

The area actually occupied by high forests, low forests, and mangrove swamps is 4,482,982 acres, representing only 16% of the total area of the Island.

A number of hard woods are utilized in rural construction and for railroad ties, telegraph poles, and fence posts. Only a few of these woods are exported, as follows: mahogany, Spanish or cigar-box cedar, Dagame, lignum vitae and sabicú. Spanish cedar and mahogany are largely used for furniture and in city houses. Notwithstanding the fact that the Cuban forests are nearly exhausted, the value of the forest products marketed in 1938 was $4,169,734.

Several laws and decrees have been promulgated for the reforestation of the Island. The Cuban Government maintains an elementary School of Forestry and several nurseries for the free distribution of valuable forest plants and seeds. In addition to mahogany, Spanish cedar, and other native species, large quantities of teak, eucalyptus, and Honduras mahogany seedlings are being distributed.

There are many melliferous plants in the Cuban flora, so that bee-keeping is very successful. The production of honey in 1938 was valued at $676,734 and that of wax at $167,986.

Some Cuban plants produce important drugs, such as curbana (*Canella alba*), Guayacán (*Guaiacum officinale*), and Cuajaní (*Prunus occidentalis*), while others are valuable for tinctorial purposes or as ornamentals. The nursery business in 1940 amounted to over $500,000 around Havana alone.

ESTACIÓN EXPERIMENTAL AGRONÓMICA,
SANTIAGO DE LAS VEGAS, CUBA.

L. N. H. LARTER: **Plant Resources of Jamaica**: — The Island of Jamaica, approximately 140 miles long and 50 miles across at its widest part, is situated in the Caribbean Sea, some 500 miles south-east of the mouth of the Gulf of Mexico, on the latitude 18° North. It thus lies in the zone of the north-east Trade Wind and enjoys a typical insular climate. Its geologic basis is a core of igneous and metamorphic rock outcropping in the Blue Mountains, a range running along the long axis (W. N. W. — E. S. E.) at the east end of the island and rising to a height of 5,000 to 7,000 feet. Overlying this is an eroded limestone plateau rising to 3,000 feet, covering the west and central parts and occupying over three quarters of the area of the island. To the south lies a coastal plain varying in width up to 15 miles, and broken at each end by subsidiaries of the central mountain ranges. The orientation and topography of the country have a profound effect on the rainfall distribution which is a determining factor in the floristic composition of the several ecological areas; temperature and soil are of secondary importance in this respect. In the north-east section from the coast to the crests of the Blue Mountain the average annual rainfall varies from 100 to 200 inches. The Central Plateau has a rainfall of 70 to 90 inches, rising to 100 inches in restricted areas while the Southern Coastal Plain and a part of the north-west section have a fall of less than 50 inches and as little as 30 inches in places. The seasonal variation in rainfall is marked. Precipitation is heaviest in May and October and, except in the north east section, there is a dry season, often a severe drought, in the winter months from January to April.

The whole of the mountainous areas are cut by numerous deep river valleys and the surface of the slopes have undergone deforestation and serious erosion so that even in the wettest areas vegetation of the tropical rain forest type is only encountered on the remoter and less accessible ridges. The higher northern slopes of the Blue Mountain region are, however, heavily wooded

and support a rich undergrowth but the soil is shallow and tall trees are the exception. The flora of this area is varied, rich in species but containing few dominants. On the ridges *Juniperus lucayana* and *Podocarpus urbanii* are common; the orchid, fern and moss flora is rich and such shrubs as *Hamelia, Boehmeria* and *Piper* predominate. Lower down on these slopes *Artocarpus integrifolia, Cecropia peltata, Andira, Erythrina, Cedrela,* and *Swietenia* are found extending to the coast. The southern aspect is drier and the vegetation more sclerophyllous; *Eugenia, Vaccinium, Pteris, Dodonaea, Gleichenia* and *Chusquea* are typical genera.

The Central Plateau carries on its northern side and in its higher parts thickly wooded areas from which the bulk of the native timber is obtained. At lower elevations park land and pasturage typify the ecotype. The central and southern sections of this area are largely given over to arable cultivation and pasturage except on the steeper slopes and hill tops which are still wooded.

The Southern Coastal Plain is clothed with grass land and xeromorphic scrub. Passing from the foot hills to the coast some of the principal species seen are *Pithecolobium saman, Tamarindus indicus, Eriodendron anfractuosum, Enterolobium cyclocarpum, Cordia alba* and *C. gerascanthoides, Guaiacum officinale, Haematoxylon campechianum, Prosopis juliflora, Cassia emarginata, Acacia tortuosa,* and *A. macrantha, Capparis ferrugineum, C. cyanophyllophora, Bursera simaruba, Blighia sapida, Cereus* spp., *Optuntia tuna* and *O. cochinellifera, Bromelia pinguin,* and on the coast itself salina and mangrove swamp is frequent. The coastal areas of the north west have a similar vegetation. With the exception of a few pockets in the Central Plateau and parts of the northern coast the southern plains are the only areas sufficiently level for extensive mechanised cultivation on a large plantation scale. Arable cultivation is largely carried out with the aid of irrigation and where water is insufficiently plentiful for this purpose, stock rearing is practised.

Jamaica is an entirely agricultural country and until recently its principal crop has been the banana which provided over fifty per cent of the export trade up to 1938, and occupied some 150,000 acres, approximately sixty per cent of the land under arable cultivation. The main banana areas were the coastal districts and valleys in the north east, the irrigated southern plains and the valleys and the lower altitudes of the Central Plateau. Panama Disease during the last twenty years has eliminated large acreages in the first two of these areas where the best banana soils are to be found and is driving this crop further up the slopes of the mountains. During the past five years Leaf Spot (*Cercospora musae*) has further reduced the industry, especially on poorer soils. Complete resuscitation can only be sought in the substitution of a resistant variety for the Gros Michel, the variety on which the industry has hitherto been based.

The sugar cane is now the most important crop and most of the diseased banana lands which are sufficiently near a factory have been planted in cane. This industry is mainly located in the Southern Coastal Plain where the cane is grown under irrigation, along certain sections of the north and north east coast and in depressions of the Central Plateau. The replacement and modernisation of factories and the substitution of mosaic resistant seedlings for older varieties and more recently the war, have proved a valuable stimulus to the progress of this industry. In normal times these two crops, cane and bananas, provided over seventy per cent of the Jamaica Export Trade.

Citrus is extensively grown especially on the Central Plateau and is becoming one of the main agricultural industries. Large areas of this region are eminently suited to this crop which is being actively developed to offset the decline of the banana trade. Grapefruit, oranges, and limes are the principal types grown and the chief outlet at present is for fruit pulps, juices and essential oils, rather than whole fruit.

Pimento (*Pimenta officinalis*) is also largely grown in the Central Plateau. This crop has been attacked by a rust disease since 1936 which has destroyed most of the trees at higher elevations. In spite of the reduction of output by about fifty per cent, the value of the industry has been maintained. Pimento is not planted, but it is from the wild trees that the crop is reaped.

Coffee cultivation is next in importance as an agricultural industry and as such is of two types. The famous Blue Mountain coffee which commands the highest prices paid is grown exclusively on the southern slopes of the Blue Mountains, at an altitude of 3,500 to 5,000 feet. Lowland coffee grown in the Central Plateau is inferior in quality though it provides the bulk of the industry. Improvement in cultivation and processing which has long been necessary is now being undertaken. In both sections of this industry *Coffea arabica* is the species in use and the high quality of the Blue Mountain product can only be attributed to the unique environment prevailing in that area. Cacao is no longer grown on a plantation scale and production is confined to humid pockets in the Central areas of the island and is largely in the hands of peasant cultivators. Nevertheless, an appreciable export trade is maintained and could probably be increased in the restricted areas of the north east where the climatic conditions are suitable.

Coconuts are extensively cultivated and except for some of the less elevated eastern areas in the Central Plateau are confined to the coastal strip extending along the north and north east shores. At the present time the crop is threatened by a Wilt disease which has already ravaged large acreages in the north west.

Ginger cultivation is an important minor industry, again largely confined to the Central Plateau and is mainly in the hands of the peasantry. Tobacco is grown in the river-side and alluvial areas in the south of the island by small contractors to the cigar manufacturers who supply a growing export trade. The tobacco grown for export is of the cigar filler type, the wrapper leaf being imported. Attempts to produce lighter flue-cured tobacco for cigarette manufacture have met with indifferent success. The export of logwood and logwood extracts is still appreciable though declining owing to competition with synthetic dyes. This tree is largely confined to the drier coastal areas and is typical of the flora of the Southern Coastal Plain.

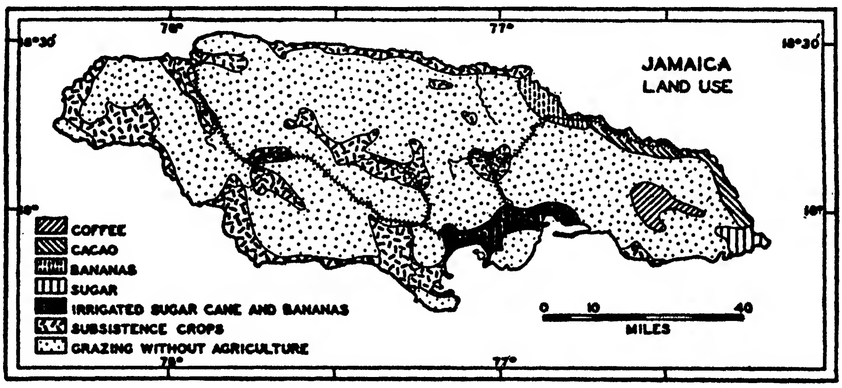
The foregoing include the most important cash crops upon which the island export trade is based. There are, however, a number of other plant products shipped in small quantities which include, in order of importance, honey, tomatoes, annatto (*Bixa orellana*), cola nuts (*Cola acuminata*), lignum vitae (*Guaiacum officinale*), quassia chips and bitterwood logs (*Picraena excelsa*), sarsaparilla (*Smilax utilis*), maize, cassava starch, divi-divi (*Caesalpinia coriaria*), satin wood (*Xanthoxylum flavum*), fustic (*Chlorophora tinctoria*). In addition, sisal plantations supply local factories which produce a high proportion of the cordage requirements of the island.

The wide variation in climatic conditions from the mountain tops to the coastal plains enables Jamaican peasantry to grow a wide range of subsistence crops for local markets. In addition to the tropical fruits, of which the most important are the mango, breadfruit, naseberry (*Achras sapota*), papaw (*Carica papaya*), pineapple, starapple (*Chrysophyllum canito*), guava, guinep (*Melicocca bijuga*), avocado, *Eugenia* spp., *Spondias* spp., and Anonaceous fruits, and the vegetables, sweet potato, ochro, chocho (*Sechium edule*), coco (*Xanthosoma* spp., *Colocasia* spp.), arrowroot (*Maranta arundinacea*), peppers (*Capsicum* spp.), cowpea (*Vigna*), pigeon peas (*Cajanus*) and peanuts (*Arachis*), temperate fruits and vegetables are readily grown, *e.g.* peaches, raspberries, strawberries, cabbages, grapes, cauliflower, artichoke, asparagus, carrots, beets, celery, parsnips and onions.

Pasture plants are an important asset as the cattle industry is large and the acreage grazed, some 350,000, is equal to the total area under arable cultivation. The grass most extensively planted for pasturage is the guinea grass (*Panicum maximum*), and to a smaller extent Wynne or molasses grass (*Melinis minutiflora*) and para grass (*Panicum barbinode*). Elephant grass (*Pennisetum purpureum*) and to an increasing extent Guatemala grass (*Tripsacum laxum*) are grown for fodder. The greater area of the grazing land is under rough pasturage comprising numerous indigenous species, the composition of which calls for botanical analysis. Among the more important grasses in these areas are pimento grass (*Stenotaphrum secundatum*) and crab grass (*Axonopus compressus*) and in drier areas Seymour grass (*Andropogon pertusus*) and Bahama grass (*Cynodon dactylon*). The grazing is mostly located on the Southern Coastal Plains, (Guinea grass) and on the more level areas of the Central Plateau (natural grassland).

In spite of extensive deforestation the timber resources are of considerable domestic importance. The majority of the timbers are hard and heavy and only a few are in demand overseas for special purposes. Small quantities of lignum vitae (*Guaiacum officinale*), Mahogany (*Swietenia mahagoni*), satin wood and sandal (*Amyris balsamifera*) have been shipped. The majority of the forests are of mixed composition and no species occur in sufficient quantity to support a large export trade. Of 117 species listed as being of local economic importance, among the most valuable are, from the Blue Mountain area, *Juniperus lucayana, Podocarpus urbanii, Laplacea haematoxylon, Prunus occidentalis, Psidium montanum, Hibiscus elatus, Calophyllum brasiliense* and *Erythroxylon areolatum,* from the Central Plateau, *Cedrela odorata, Swietenia mahagoni, Dipholis* spp., *Brosimum alicastrum, Terminalia latifolia, Pithecolobium alexandri, P. arboreum, Nectrandra* spp. and *Antirrhoa jamaicensis,* and from the dry coastal plains, *Peltophorum brasiliense, Petitia domingensis, Cordia gerascanthoides, Piscidia piscipula,* and *Catalpa longissima,* etc.

It will have been noted that few if any of the important economic plants now grown in Jamaica are truly indigenous. While related species of economic genera are represented in the wild flora it is doubtful if further exploitation will bring valuable new species to light. Except for limited and inaccessible areas the island has been thoroughly collected by systematists and new species which will be found in the future will almost certainly be rare or inconspicuous. Even the more thinly populated and inaccessible regions are visited periodically by a few enterprising members of the peasantry who are generally well acquainted with the flora in so far as it is adaptable to human use. The future of plant exploitation in Jamaica must therefore depend on introductions or the breeding of improved varieties. The present tendencies are directed towards replacement of the declining banana trade by the extension of other major crops such as sugar and citrus and towards a readjustment of the balance of peasant food crops with a view to increasing the protein-carbohydrate ratio in the diet. Investigations and ex-




(*From* JAMES's Latin America, New York 1942)

perimentation along these lines are now being actively pursued by the official bodies concerned.

DEPARTMENT OF SCIENCE
AND AGRICULTURE,
KINGSTON, JAMAICA.

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L. R. HOLDRIDGE: **A Brief Sketch of the Flora of Hispaniola:** — Near the middle of the northern arc of the West Indian islands and closest to the deepest portion of the Atlantic Ocean rests the second largest of the Greater Antilles, Hispaniola.

The island provides many interesting notes for the history of the New World, leading up to the present status of two republics, the Dominican Republic of Spanish culture on the eastern end and the Republic of Haiti of French culture on the smaller western portion. During colonial days the island was known as the Pearl of the Antilles and its plantations produced tremendous quantities of coffee, sugar, tobacco, cacao, indigo and precious woods for European markets. The change in economic systems of tropical agriculture has had its effect on the vegetation of the island since the swing of emphasis to subsistence farming pushed agriculture into the mountains and poorer lands where only shifting cultivation could maintain the worker. This is markedly distinct in the two republics due to the difference in population density, Haiti having a dense rural population with only scattered remnants of untouched vegetation left and the Dominican Republic with a surprisingly low population and vast areas of apparently virgin forest existing even in the lowlands.

As seen on the map, the island is of very irregular shape and since the frontier runs roughly north and south across the island without following any particular natural barrier the vegetation can hardly be treated by separate countries. The one natural division of the island is a low plain cutting east and west across the island between Port au Prince and Barahona. The several brackish, below sea-level lakes in this plain suggest that the sea might once have covered this whole stretch between the long range of east west mountains in the south and the several ranges which course roughly east and west through the larger northern portion of the island uplands. West of La Vega in the Dominican Republic one peak is said to reach over 10,000 feet in elevation while southeast of Port au Prince, Morne la Selle, which is Haiti's highest peak is approximately 8400 feet above sea level. Interestingly, Morne la Selle and many of the high ranges of the island are of limestone rock. The mountains are very important in the distribution of vegetation due to their lifting the moisture laden trade winds which come in from the east and northeast. In general, Haiti, being west of the mountains is much drier than the Dominican Republic.

Derivation of the flora in the Greater Antilles is largely from the North American continent to the west, but considerable endemism suggests a long time since land connections were broken. The eastward migration is further pointed up by noting that several notable genera such as *Swietenia* and *Pinus* did not attain to Puerto Rico to the east. Many of the well-known exotics brought into the West Indies are common on the island but there is far from the superabundance of introduced species as found in Puerto Rico.

The accompanying type map is intended to give a rough idea only of the locations of the main vegetation regions of the island. The various ranges of mountains in the main body of the island cut up the types considerably and could only be delineated on a large map. For similar reasons the types shown are limited to three, although there are additional types of limited distribution and some of the major categories would readily stand further division.

One of the smaller but distinct types common and similar throughout the West Indies is the mangrove swamp. This is best developed in Samaná Bay, along the north coast between Monte Christi and Cape Haitian and in the Gonave Bay but likewise occurs at all poipts along the coast where tidal mud flats are formed. The four mangroves which make up the type are *Rhizophora mangle, Laguncularia racemosa, Avicennia nitida* and *Conocarpus erecta.*

The dry forest comprises the vegetational category with the largest area. This will surely be broken down into several types in the future as more knowledge of the island and tropical American types are compiled. Some of these comprise small total acreage but are quite distinct. On raised sandy beach levels, one finds an association of *Coccolobis uvifera, Plumeria, Calophyllum antillarum* and *Bucida buceras.* Good examples of such forest may be found at Sosua, east of Puerto Plata in the Dominican Republic. Another such type is probably the most typical savanne in the West Indies with *Curatella americana* and *Byrsonima.* Associates of this savanne type on the island are *Anacardium occidentale* which resembles the *Curatella* at a distance and shrubs of *Brya buxifolia* and *Pictetia.* This may be seen just north of Ciudad Trujillo or at the foot of the mountains on the northern coastal plain of Haiti. In the latter place the savannas may be several miles in length and are surrounded also by scattered pine trees which descend here to about two hundred feet above sea level.

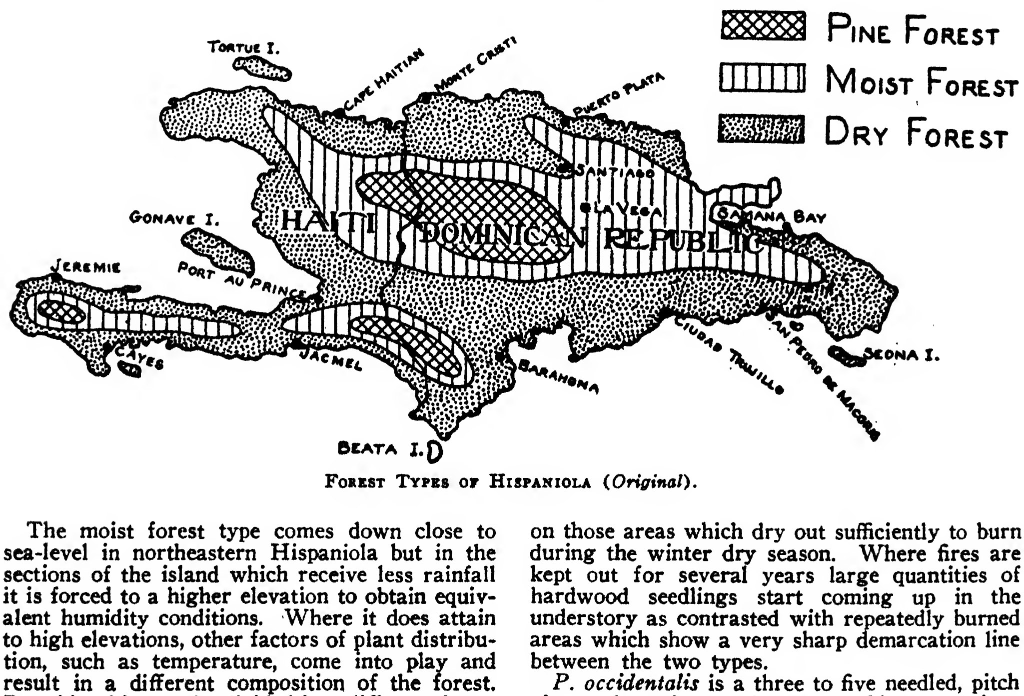
Because of their occurrence in the lowlands and their many species of cabinet woods, the dry forests in the West Indies have been mostly culled through or altered by the hand of man, but the Dominican Republic still contains large areas of virgin forest of this type and offers the best location for the ecologist who wishes to study this association. Especially is this true of the eastern end of the island but good stands of easy accessibility may be seen along the Ciudad Trujillo-Barahona highway. Some of the important timber species are *Swietenia mahagoni, Guaiacum officinale, G. sanctum, Lysiloma latisiliqua, Cordia alliodora, Krugiodendrum ferrea, Acacia scleroxyla, Colubrina ferruginea, Petitia domingensis,* and *Phyllostylon brasiliensis.*

With the wide range of drought prevailing on the island, there seems to be a logical division of what has been mapped as dry forest into two divisions which might be designated as dry and

arid types. It is a somewhat difficult segregation to make by species but this difficulty is largely due to lack of sufficient knowledge. *Cassia spectabilis, Cordia alliodora* and *Lysiloma* would seem to typify the dry section with the interesting palm, *Pseudophoenix vinifera* coming right to the edge of the arid section. The arid side seems to be typified by tree cactus such as *Lemaireocereus hystrix, Cephalocereus, Opuntia moniliformis* and *Peireskia*, by *Casearia illicifolia* and many other small trees and shrubs. On the other hand, there are a great many species such as *Ceiba pentandra, Elaphrium simaruba, Bombax ellipticum, Metopium brownci, Guaiacum, Phyllostylon, Haematoxylon campechianum, Prosopis juliflora* and many *Leguminosae* which traverse the whole area of drought and make one realize that setting up types is just as difficult as defining species exactly. In some areas the tree cacti stand out as the dominant vegetation but this is usually due to heavy removal of the hardwood species for charcoal. Small savanna like openings in the arid section are occasionally met with and are probably due to heavy alkali concentrations in the soil.

*nus occidentalis, Dendropanax arborea, Sloanea illicifolia, Weinmannia pinnata, Maytenus domingensis, Coccolobis neurophylla, Laplacea alpestris* and several trees of the *Lauraceae*. The forests are dense and difficult to enter because of the bamboo grasses which run rampant on the sunny edges of the thickets. Epiphytic orchids, ferns, mosses, liverworts and lichens are abundant on the tree trunks and on exposed ridges or peaks the stand is the typical mossy or montane forest of the West Indies.

The last remaining major type on the island is that of the one wide spread conifer, *Pinus occidentalis*. The type is more interesting commercially than botanically since the vegetation is much less rich than in the hardwood types. It has been the basis for many diverse ecological explanations. It is found on different soils over widely differing rock formations and the range of elevations at which it grows is almost as great as that of the island itself. Hardwood forests grow around it and in islands within the pine forest itself. The only logical explanation seems to be that of fire as the pine throughout the island maintains itself in pure stands only




FOREST TYPES OF HISPANIOLA (*Original*).

The moist forest type comes down close to sea-level in northeastern Hispaniola but in the sections of the island which receive less rainfall it is forced to a higher elevation to obtain equivalent humidity conditions. Where it does attain to high elevations, other factors of plant distribution, such as temperature, come into play and result in a different composition of the forest. Roughly, this may be divided into different forest types although further study may show the need for still further subdivision.

In general, forests at low elevations through the Antilles seem to contain more species in common than the forests in the higher mountains. The low moist forest in Hispaniola produces as evidence such common trees as *Cecropia peltata, Manilkara nitida, Tetragastris balsamifera, Didymopanax morototoni, Guarea trichiloides, Genipa americana,* and *Inga*. The understory is rich in shrubs, vines, ferns, and other herbaceous plants.

The high mountain hardwood forest in the southern range of Hispaniola represents the other extremity of the moist forest scope. There the conspicuous arboreal elements are *Didymopanax tremulans, Brunellia comocladifolia, Pru-*

on those areas which dry out sufficiently to burn during the winter dry season. Where fires are kept out for several years large quantities of hardwood seedlings start coming up in the understory as contrasted with repeatedly burned areas which show a very sharp demarcation line between the two types.

*P. occidentalis* is a three to five needled, pitch pine and attains to the respectable proportions of four feet in diameter and one hundred and fifty feet in height. The forest itself with long vistas of grass and brake between the trunks, the patches of ripening blackberries and the scattered dandelions, moth mullein and beds of wild strawberries about one are decidedly reminiscent of temperate climes. This is true of the high mountain pine forest. At lower elevations as in north central Haiti, the pine forest seems quite distinct, is decidedly less dense and tends more towards a savanna type of forest.

One other conifer of limited extent which grows in nearly pure stands is *Juniperus lucayana*. Probably several hundreds of acres in totality of this type exist scattered through the mountains and foothills on the southern side of the central mountains in the Dominican Repub-

lic. This attains sizes over three feet in diameter and has been exploited to a limited extent as pencil wood.

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Port-au-Prince, Haiti.

H. D. Barker*: **Plant Resources of Hispaniola:** — The Island of Hispaniola is the home of two Republics. Haiti occupies the western third, and Santo Domingo the eastern two-thirds of the Island. It is the second largest of the Antilles group, and lies between Cuba and Puerto Rico, occupying a position between the 18th and 20th parallel north. It is, thus, just within the tropical zone. Its favorable location, varied topography and climate, and fertile soils contribute to the richness of its plant resources.

Both Republics are characterized as mountainous with comparatively narrow coastal-plain borders and relatively narrow valleys leading into the highlands. There is one rather extensive central plateau, and a number of smaller plateaus or plains. The topography is dominated by a high mountain mass extending in an east-west direction. Trujillo Peak in Santo Domingo is about 10,500 feet high, the highest elevation in the Antilles. Morne la Selle, slightly under 9,000 feet, is the highest mountain in Haiti. The mountains are broken into a number of spurs and parallel chains. Lake Enriquillo lies in the below-sea-level depression near the southern border of the two Republics. The Island has a number of sizeable rivers that arise in the mountains and maintain a good flow the year round. In a number of localities irrigation is practiced or is feasible.

The climate is much more varied than might be expected in an island of about 30,000 square miles. The high mountains and trade winds are largely responsible for a varied flora that ranges in type from tropical to temperate and from desert to jungle rain forest.

By far the greater part of the Island has soils that are formed from limestones, sandstones, shales, and conglomerate. There are some rather extensive intrusions of granite. The soils of Hispaniola have long been noted for their high fertility. There is a great multiplicity of soil types.

With this brief sketch of the varied topography and generally favorable climate and soils, it may be readily realized that there is a diverse agriculture and a wealth of plant resources in the Island of Hispaniola. The western part is more densely populated and intensively cultivated, whereas the eastern part is much richer in forest resources and in grazing plants.

*CYCADACEAE.* — In the eastern tip of Santo Domingo, ***Zamia integrifolia*** and ***Z. media*** occur in sufficient abundance to be annoying in grazing land. The underground stem is reputedly rich in starch, but has not been exploited.

*PINACEAE.* — While several species of conifers have been introduced and thrive as ornamentals, and although there are at least two native species of ***Juniperus***, the important gymnosperm is ***Pinus occidentalis***. Forests that yield turpentine and lumber occur usually at elevations above 2,500 feet.

*POACEAE.* — This important family has many introduced and indigenous species that are of great economic value. ***Zea mays*** is widely cultivated for food and feed throughout the Island. Guatemala grass, ***Tripsacum laxum***, is cultivated to a limited extent.

*Saccharum officinarum*, from colonial times to the present, is one of the very important sources of wealth. The recent introduction of disease-resistant and improved varieties of sugar cane has greatly increased the profitableness of sugar production. Many fields have been in continuous crops for several decades and are still productive without the addition of commercial fertilizers. Although some cane is grown without irrigation, supplemental irrigation is usually practiced. Since intensive cultivation and rail transportation are required, the crop is usually grown on the level or slightly rolling land of the coastal plains or valleys.

*Vetiveria zizanioides* and *Cymbopogon nardus* are cultivated on a small scale for medicine, for aromatic tea, or for perfume.

*Sorghum halapense* and *Sorghum vulgare* are important sources of forage, and the latter is widely cultivated for food.

*Themeda quadrivalvis* is the dominant grass of the central plateau and is of great value for grazing. Many native species of *Paspalum, Panicum, Setaria, Sporobolus, Chloris, Eragrostis,* etc. are of varying importance for grazing. Probably the most important "cultivated" pastures are formed from *Cynodon dactylon, Panicum purpurascens* (Para grass), and *P. maximum.*

*Oryza sativa* L. is widely cultivated by inundation and also as "upland" rice.

The grass family could not well be dismissed without calling attention to *Bambusa vulgaris* that grows so rapidly and is so useful for construction and for many other purposes.

*PHOENICACEAE* and *CYCLANTHACEAE.* — The palm family is well represented and is of very great importance in the economic life of the Island. For making hats, ropes, etc., the leaves of *Carludovica palmata,* and various native or cultivated species of *Thrinax, Coccothrinax, Washingtonia, Sabal* and others are used. The widely grown and stately *Roystonea regia* is used for posts and for construction. Lumber is made from the trunk; the leaves are used for thatching; the "heart" or tender bud is used for salad; and the seeds are used for feeding swine. *Elaeis guineensis,* the African oil palm, is an important source of oil in local areas. ***Cocos nucifera*** is cultivated throughout the lowlands and is of immense value for supplying food and oil, for piling, thatching, etc.

*ARACEAE.* — ***Colocasia esculenta*** is an important and widely grown food plant.

*BROMELIACEAE.* — ***Ananas comosus*** has given rise to several varieties of pineapple that are grown for local consumption or for export. Spanish moss, ***Dendropogon usneoides*** and many species of ***Tillandsia*** are conspicuous in the forests but are little used.

*LILIACEAE.* — Several species of ***Allium*** are cultivated for food, as is ***Asparagus officinalis, Aloe vera*** and ***Sansevieria thyrsiflora*** are common but are not exploited.

*AMARYLLIDACEAE.* — Several native and introduced species of ***Agave*** and ***Furcraea*** furnish fiber. Sisal, for several years, has been a major export crop.

* Formerly of the Department of Agriculture, Republic of Haiti, and later chairman of the committee investigating the settlement potentialities in the Dominican Republic under the auspices of the President's Advisory Committee on Political Refugees.

*DIOSCOREACEAE.* — Several species and varieties of *Dioscorea* are grown for food.

*MUSACEAE.* — *Musa paradisiaca* and related species provide the Island with a very valuable food and export crop.

*ZINGIBERACEAE.* — *Zingiber officinale* is grown, but little ginger root is exported.

*ORCHIDACEAE.* — Although many wild forms of beautiful orchids occur, there are few collections of cultivated types. *Vanilla planifolia* is occasionally cultivated, but the vanilla bean or extract is rarely exported.

*CASUARINACEAE.* — *Casuarina equisetifolia* is cultivated, although little attention has been given to the use of the wood or the tannin in the bark.

*JUGLANDACEAE.* — *Juglans jamaicensis* of the high mountains has a beautifully grained wood.

*FAGACEAE.* — *Fagus sylvatica* and *Castanea sativa* were introduced in colonial times, and do well at high elevations.

*ULMACEAE.* — The family contains important timber resources, particularly *Phyllostylon brasiliense*, and species of *Celtis, Ampelocera*, and *Trema*.

*MORACEAE.* — *Chlorophora tinctoria*, a fine-grained hard wood known in commerce as "Fustica," formerly an important source of khaki dye; *Artocarpus communis*, the valuable breadfruit tree; various species of *Ficus;* and *Castilla elastica* indicate the importance of this family of trees as a source of construction and cabinet wood, dye, food, and rubber.

*CHENOPODIACEAE.* — *Beta vulgaris* is widely cultivated at higher elevations.

*NYCTAGINACEAE.* — Were one to ignore the several species of trees of *Pisonia* and *Neea*, such ornamental plants as *Mirabilis jalapa* and *Bougainvillea glabra, B. spectabilis*, and *B. intermedia* could not well be ignored.

*MAGNOLIACEAE.* — *Magnolia domingensis, Michelia champaca*, and *Illicium parviflorum* are representative of this family on the Island.

*ANONACEAE.* — This is a very important family of Hispaniolan trees represented by the genera *Oxandra, Guatteria, Cananga, Rollinia*, and *Anona*. *A. cherimola* produces what many consider one of the world's finest fruits.

*LAURACEAE.* — The family contains a number of valuable trees including *Cinnamomum camphora, C. zeylanicum* (Cinnamon tree), and *Persea americana*. The Avocado pear is important in commerce and as an agreeable source of fats in human nutrition.

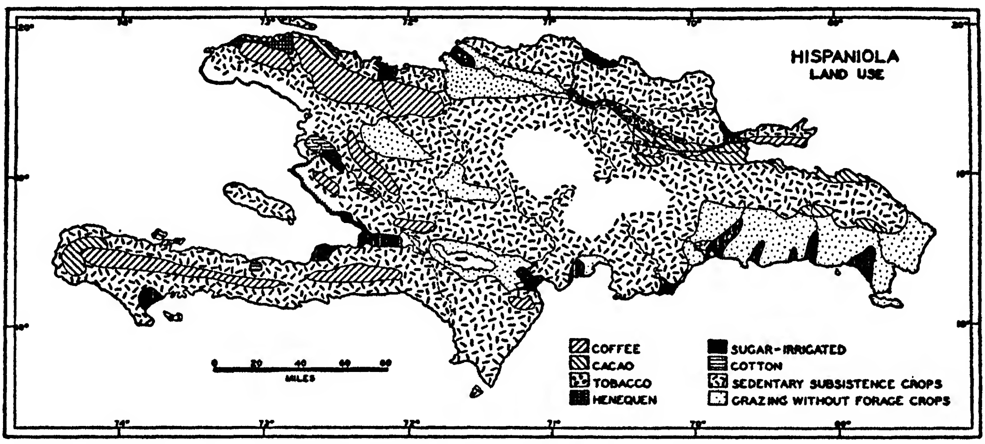
*BRASSICACEAE.* — Several members of the family are cultivated in the cooler regions of high elevation.

*ROSACEAE.* — Many of the well known fruits and berries of the temperate climate grow at high elevations and supplement a number of native species of trees, shrubs, or herbs.

*FABACEAE.* — This is an extremely large, very valuable family of plants in Hispaniola. In addition to the many temperate climate species that have been introduced for food or feed, there are many somewhat similar introduced or native tropical forms. Space will not permit listing many of the important herbaceous plants, or the great number of ornamental and useful trees and shrubs. A few of the tropical forms of especial interest or importance may be cited as examples. *Inga vera* is widely planted to provide shade for coffee and cacao. *Acacia lutea, A. scleroxyla*, and other species produce valuable construction timber. *Prosopis chilensis* provides much of the charcoal used for cooking. The pods of *Tamarindus indica* are eaten or used in making candy. *Haematoxylum campechianum* gives the Logwood of commerce for extracting dye. It is an important honey plant. *Delonix regia*, or "Flame tree," is famous for its beauty. Of the many interesting and valued herbaceous plants, it may be interesting to note that *Indigofera tinctoria* persists as a reminder of colonial indigo culture. *Erythrina indica* is a beautiful ornamental tree that roots so easily that cuttings are often used to make living fence posts. *Cajanus indicus*, "Pigeon pea," makes an important contribution to the diet in many tropical countries.

*ZYGOPHYLLACEAE.* — *Guajacum officinale* gives the "Lignum vitae" of commerce. It is widely used for bearings, especially underwater bearings, and for many other purposes where a very dense, hard wood is required. The structure of the wood is such that it is difficult to work with ordinary woodworking tools.

*RUTACEAE.* — This family has several genera of trees with valuable wood. Many species of *Citrus* are widely cultivated for domestic




(*From* JAMES's Latin America, New York, 1942)

and export market. Some unusual types of seedling oranges merit study as to commercial possibility.

*SIMARUBACEAE* and *BURSERACEAE.* — Species of *Bursera, Simaruba,* and related genera occur in sufficient abundance to provide lumber suitable for packing cases or other purposes.

*MELIACEAE.* — This family of valuable trees is represented by six genera, some of which have several species. Mahogany produced in Hispaniola from *Swietenia mahogani* is said to be the world's finest cabinet wood. The tree thrives on many soil types in regions of moderate rainfall, at low to moderate altitudes. *Cedrela odorata* is also important in commerce for making cigar boxes, chests, etc. The sister genera are interesting, especially the magnificent tree, *Carapa guianensis.*

*EUPHORBIACEAE.* — This large family of tropical trees, shrubs, and herbaceous plants must be treated here too briefly to adequately represent their importance in the Island's flora. Of the several genera of trees, *Hevea brasiliensis* has of recent years been receiving most attention. Several regions where experimental plantings have been made appear to be well adapted to rubber production. Of the herbaceous plants, *Manihot utilissima* is of great economic importance. It is widely grown for food, and one or more commercial starch plants are in operation. *Ricinus communis* is prevalent but is little exploited for castor oil production.

*ANACARDIACEAE.* — *Mangifera indica* is widely cultivated at low elevations for domestic consumption and for export. Although propagation is largely by seedlings, there are several distinct varieties of mango. *Anacardium occidentale* provides cashew nuts for domestic consumption and for export.

*SAPINDACEAE.* — Apart from several genera of trees, some with fine-grained wood, the family is of especial local interest for the "soap berry" of *Sapindus saponaria* and for the edible fruits of *Melicocca bijuga* and *Litchi chinensis.*

*RHAMNACEAE.* — The family contains several species and genera of trees and shrubs, mostly with wood of a dense structure, that are of local interest.

*MALVACEAE.* — Of the many genera of herbaceous plants, mention here will be limited to fiber-producing plants that are used locally or for export. There are several species of the following genera: *Urena, Pavonia, Hibiscus,* and *Gossypium.* Cotton is produced for export.

*BOMBACACEAE.* — Some of the largest trees of the Island belong to this family, as *Adansonia digitata, Ceiba pentandra,* and species of *Bombax and Pachira.* The wood is usually soft and very light; *Ochroma pyramidalis* is especially light. Seed floss or fibers from *C. pentandra, Neobuchia paulinae,* and *O. pyramidalis* are used locally for pillows etc. or are exported.

*STERCULIACEAE.* — Although the Island has several genera of trees and shrubs belonging to this family, *Theobroma cacao* is of outstanding importance. Commercial cacoa production dating from the colonial epoch extends throughout the Island, especially in regions of moderate elevation and good rainfall.

*HYPERICACEAE.* — *Mammea americana* is cultivated for its edible fruit and as an ornamental tree. *Calophyllum calaba* and species of related genera provide valuable construction wood.

*FLACOURTIACEAE.* — This family contains several genera of native trees, few of which have received especial attention in evaluating the Island's forest resources.

*PASSIFLORACEAE* and *CARICACEAE.* — There are several species of *Passiflora,* including the cultivated *P. quadrangularis,* or "Grenadine." *Carica papaya* is widely cultivated for domestic consumption and for export trade.

*RHIZOPHORACEAE* and *COMBRETACEAE.* — *Rhizophora mangle, Conocarpus erectus,* and *Laguncularia racemosa* are important sources of tannin. Other genera contain valuable trees and shrubs.

*MYRTACEAE.* — This large family of trees and shrubs, many of which are aromatic, is well represented on the Island. *Pimenta acris,* the Bay-Rum tree, *Pimenta officinalis,* Allspice tree, and species of *Eucalyptus* are sparingly cultivated. *Psidium guajava,* Guava tree, is widely cultivated. In addition, there are a great number of valuable native trees and shrubs.

*SAPOTACEAE.* — This is another large family of trees and shrubs that furnishes many tropical fruits, the more important of which are *Achras zapota, Calocarpum mammosum, Lucuma domingensis,* and *Chrysophyllum cainito.*

*APOCYNACEAE.* — Many native species of *Plumeria* have showy flowers that seem too perfect to be real. *Lochnera rosea* and *Nerium oleander* beautify nearly every garden in the Island, and *Funtumia* thrives in at least one planting.

*ASCLEPIADACEAE.* — *Cryptostegia grandiflora* was a common ornamental woody climber until large-scale cultivation for rubber production was recently undertaken.

*CONVOLVULACEAE.* — *Ipomoea batatas,* or sweet potato, is generally cultivated for food.

*MENTHACEAE.* — The family is represented by about twenty genera, including many of the temperate-climate cultivated mints and ornamental plants.

*SOLANACEAE.* — Many of the important cultivated plants of the temperate climate are common in addition to many native species, including several shrubs and trees.

*BIGNONIACEAE.* — *Spathodea campanulata* is a beautiful ornamental tree. Although *Catalpa longissima* is extensively used as a cabinet wood, it might be more profitably exploited. More than twenty-five related species and genera of trees add to Hispaniola's forest resources.

*RUBIACEAE.* — Hispaniola has more than fifty genera of trees, shrubs, and herbs in this family. Included is *Coffea arabica,* the principal source of the Island's wealth. Since early colonial times, vast quantities of coffee have been exported annually. It is chiefly grown on the rolling or mountainous lands where rainfall is moderate to heavy.

*CUCURBITACEAE.* — Many of the vegetables and melons common elsewhere have been introduced and are valuable crops for domestic consumption or for export. Of the less familiar types, *Momordica charantia, Luffa aegyptiaca* and *L. acutangula* are interesting. *Sechium edule* produces a fruit similar to the squash, which is cooked in several ways. The leaves are also consumed as "greens."

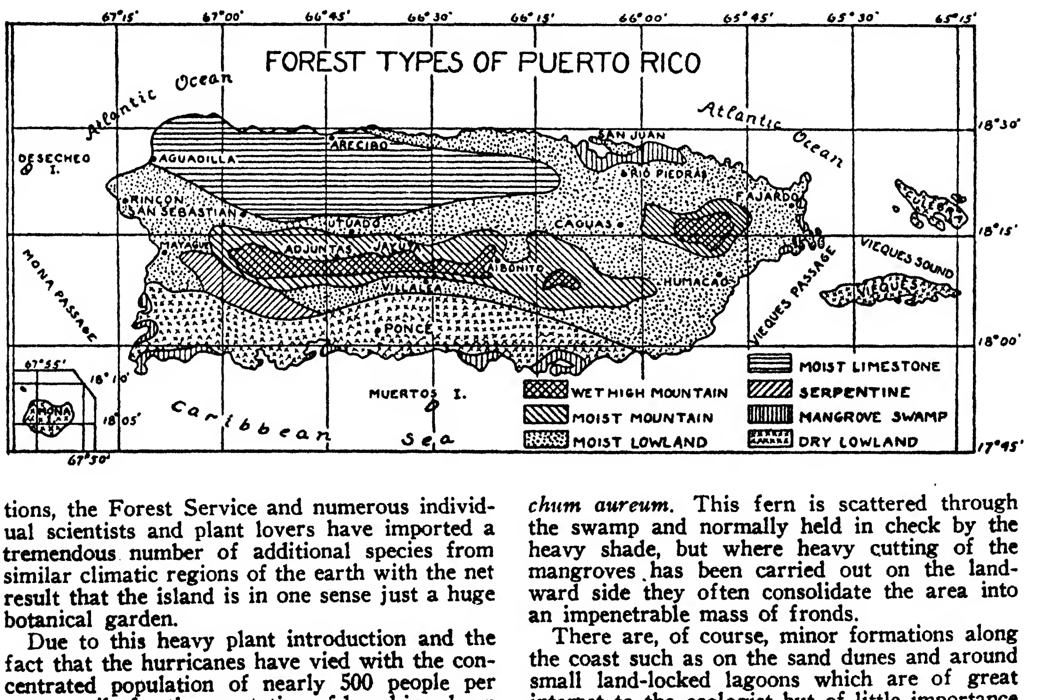
*ASTERACEAE.* — This large family is abundantly represented in Hispaniola. In addition to the many ornamental plants of the temperate zone,

as *Zinnia, Dahlia,* etc., and vegetables, as *Lactuca* and *Cynara scolymus* (artichoke), some of the temperate-zone weeds have become established at high elevations. The numerous native species are largely herbaceous plants of little economic value.

From the above brief sketch, it may be readily realized why Hispaniola is sometimes spoken of as a "Botanist's Paradise," and that, from an economic standpoint, the Island is exceedingly rich in plant resources.

U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

L. R. HOLDRIDGE: **A Brief Sketch of the Puerto Rican Flora:** — The small rectangle measuring approximately 100 miles by 30 miles known as Puerto Rico rises up from the deep blue waters of the Caribbean Sea to a height of slightly over 4000 feet, and within this three dimensional range bears upon its surface a complex vegetation comprising a multitude of tropical and sub-tropical plants. As if this number of plants were not sufficient, the Experiment Stations, the Forest Service and numerous individual scientists and plant lovers have imported a tremendous number of additional species from similar climatic regions of the earth with the net result that the island is in one sense just a huge botanical garden.




Due to this heavy plant introduction and the fact that the hurricanes have vied with the concentrated population of nearly 500 people per square mile for the reputation of knocking down the most plant growth, it is a difficult task to divide the island into true forest types or plant associations, and surely it will take much more understanding of tropical types combined with study of less disturbed areas in the region before this may be determined accurately.

The accompanying forest type map, worked out by the Tropical Forest Experiment Station, segregates the vegetative growth of the island into seven main types. It is essentially a combination of contour, rainfall and rock formation maps built up after long observation and study of associations in the field. There is considerable resemblance between the flora of Puerto Rico and of the other Greater Antilles to the west but several noteworthy species which are common to two or three of the other islands such as mahogany and pine never quite reached Puerto Rico in their march eastward from the North American continent. Again to the eastward there is a close resemblance down to and including Guadeloupe but beyond this point the similarity fades as the South American influence becomes more marked.

Of the seven types of the island, the mangrove swamps constitute the simplest and most closely resemble their counterpart in the adjacent islands. *Laguncularia racemosa* and *Avicennia nitida* comprise the majority of the individual trees in these swamps with *Rhizophora Mangle* growing alone on the deep water sides. Few large trees remain and the *Conocarpus erecta* which frequented the drier parts of the marshes and the adjacent dry lands has been largely removed by man. The sickle-fruited *Drepanocarpus lunatus* is found occasionally through the area as a shrub or small tree and the white flowered vine, *Rhabdadenia biflora,* is common. The ribbon buttresses of the *Pterocarpus officinalis* allow it to invade edges of the swamps but the most aggressive invader is the tall *Acrostichum aureum.* This fern is scattered through the swamp and normally held in check by the heavy shade, but where heavy cutting of the mangroves has been carried out on the landward side they often consolidate the area into an impenetrable mass of fronds.

There are, of course, minor formations along the coast such as on the sand dunes and around small land-locked lagoons which are of great interest to the ecologist but of little importance in a study of the island as a whole. Practically all around the coast and usually too narrow to be indicated on the type map the drying winds give rise to a vegetation nearly identical with the extensive dry lowland area in the southern and southwestern portions which are cut off from the rain-bearing northeast trade winds by the range of mountains running east and west through the center of the island. Since most of the flat fertile lands have been cleared and irrigated for high production agriculture, the remaining natural vegetation consists largely of scrubby woodlands on the dry hills.

Aside from the extensive fields of sugar cane and the widespread pasture lands planted with *Panicum maximum,* woody species characterize the type. Many of these are spiny as if to

match with the tree-cactus, *Cephalocereus*, the numerous opuntias and an occasional colony of *Melocactus communis*. A few of the characteristic trees are *Bucida buceras, Ceiba pentandra, Elaphrium simarouba, Guazuma ulmifolia, Pictetia aculeata, Cordia glabra, Guaiacum officinalis, Krugiodendron ferreum, Tabebuia heterophylla, Andira inermis, Sapindus saponaria, Colubrina reclinata, C. ferruginea, Lonchocarpus domingensis*, the beautiful flowered *Phlebotaenia Cowellii, Pisonia albida, Torrubia fragrans, Elaeodendrum xylocarpum, Sarcamphalus reticulatus, Thyana portoricensis, Stahlia monosperma*, and several species of *Eugenia, Capparis* and *Bourreria*. The shrubby *Comocladia Dodonaea* poisons most of those who contact its spiny leaves and occasionally extensive colonies of *Agave* add to the troubles of the traveller through the woods. Groves of coconut palms occur along the coast and *Thrinax microcarpa* forms large colonies on some of the rocky hills. A few *Phoenix dactylifera* are planted here and there but one of the most striking palm groups is that of *Sabal causiarum* near Cabo Rojo which forms the basis of a local hat industry. A description of the type would not be complete without mention of the heavy roadside plantings of the exotic *Delonix regia*, although this is common too in other types.

What is indicated as the moist lowland type has been completely cleared or altered by the hand of man. Here again, sugar cane holds the upper hand on the best lands although pineapples, grapefruit plantations and vegetable gardens cover large areas. Near the larger towns considerable land is held by the dairy industry with large plantings of *Eriochloa polystachya* and *Panicum purpurascens* for cut feed. The natural cover which the early Spaniards found must have consisted of a high luxuriant forest with abundant lianas and under story shrubs as well as numerous ferns and other herbaceous ground cover. Some of the immense trunks encountered would surely have been *Manilkara nitida, Vitex divaricata, Hymenaea Courbaril, Ficus* sp. and *Calophyllum antillanum*, the first two of which were heavily drawn on for construction of the early towns and haciendas. *Cecropia peltata, Byrsonima spicata, Inga vera, I. laurina* and several *Lauraceae*, though attaining smaller sizes would have been common elements in the forest. Today umbrageous *Hura crepitans* shade the cattle in the pastures, *Bromelia pinguin* is common as a living hedge and *Tabebuia pallida* and *Psidium Guajava* take over unattended pastures. An occasional *Roystonea borinquensis* stands like a concrete pillar and several species of *Casearia* and *Cestrum diurnum* crowd up close to the fences. But along the roads and in the towns *Delonix regia, Mangifera indica, Cassia siamea, Terminalia catappa, Spondias Mombin, Albizzia Lebbek* and many other exotics constitute the major part of the tree species.

The moist mountain type is essentially a continuation of the moist lowland type with the addition of more species. However, the combination of *Manilkara nitida* with *Dacryodes excelsa* and *Sloanea Berteroana* gives a clearly marked definition for this formation, especially in the eastern portion of the island. Agriculture has claimed the majority of this land with extensive plantings of *Inga* shaded coffee, a crop largely confined to this type, tobacco, some sugar cane, food crops, and large amounts of pasture land with main dependence on the native grasses. There is probably no remaining virgin forest of this type but the component species may easily be determined even in heavily culled forests. The dense jungle growth with corresponding difficulty of passage for the traveller is largely the result of the influence of man as opening up the stand gives rise to abundant bush and vine growth.

Besides the trees mentioned in the moist lowland type, the conspicuous arboreal elements are *Buchenavia capitata, Tetragastris balsamifera, Ormosia Krugii, Mayepaea domingensis, Chione venosa, Didymopanax morototoni, Ilex guianensis, Lonchocarpus latifolius, Casearia arborea, Prunus occidentalis, Guarea trichiloides, Hirtella triandra, Sideroxylon portoricensis, Homalium racemosum, Genipa americana, Ochroma lagopus, Pariti tiliaceum*, and numerous species of the *Lauraceae* such as *Ocotea leucoxylon, O. moschata, O. portoricensis, O. cuneata*, several *Nectandra, Persea gratissima* and *Phoebe elongata*. Among the shrubs are numerous *Melastomaceae, Piper aduncum, P. blattarum* and several *Rubiaceae*, of which *Psychotria, Palicourea* and *Hamelia* are the most common. Ferns are abundant with many mosses and liverworts. The plumes of *Andropogon virginicus* are conspicuous in the pasture lands. *Dicranopteris bifida* and *D. pectinata* take over road-cuts and landslides and the stinging leaved *Urera baccifera* is considered an indicator of good coffee soils. *Dieffenbachia seguine* forms small colonies in wet forest swales and various other *Araceae* climb on the trunks of trees or rock ledges. The *Roystonea borinquensis* occurs occasionally and *Euterpe globosa* is common but not as conspicuous here as in the higher mountain type because of the taller trees with which it contends for space and light. *Jambosa Jambos* often takes over abandoned fields or pastures to form dense copses.

Climbing above this is found the designated wet high mountain type. This is decidedly wet but at the same time carries a hint of the xerophytic as indicated primarily by the smaller leaves and due probably to the strong winds and the highly acid condition of the soil. The characteristic trees of this type are *Magnolia splendens, M. portoricensis, Ocotea spathulata*, 3 species of *Micropholis, Calycogonium squamulosum, Croton poecilanthus, Matayba domingensis, Didymopanax Gleasonii, Tabebuia rigida, T. Schumanniana*, and *Cyrilla racemiflora*, the latter attaining to diameters of six feet. The *Myrtaceae* are well represented with several species of *Eugenia* and *Calyptranthes* and *Melastomaceae* are abundant. *Guarea ramiflora, Daphnopsis Philippiana, Hedyosmum arborea*, tree ferns and some composite shrubs are common in the understory.

*Euterpe globosa* is so common in certain spots that it is often accorded type status but apparently it is a bit of an opportunist and takes full advantage of any space created by landslides or hurricanes. Lycopodiums hang from the trees and Selaginellas form a dense ground cover in spots. Sphagnum moss forms an occasional bed and numerous mosses may be collected from the ground, rocks, and tree-trunks. Travel through the forest is very difficult without a machete and even then is slow due to the dense cover of razor-edged saw-grass, a sedge, bamboo grasses and *Clusia* vines.

On the very highest peaks and ridges, this type is much reduced in height by the severe growth conditions and there it is often referred to as the dwarf or mossy forest. Actually, however, the species composing the stand are about the same. The adjective mossy is derived from the many pendant moss-like lichens on the trunks and branches.

Descending once more to the lower country in the northwestern portion of the island brings one to the moist limestone type similar to the cock-pit country of Jamaica. Near to the coast, the spaces between the hills are much greater and one often finds the curious haystack hills or mogotes rising up from fields of sugar cane or other crops. These hills are often covered with vegetation similar to that of the dry lowlands. Towards the interior, the hills become more crowded until the condition is reversed with a resulting peneplain of limestone pitted with deep sinkholes. Here the forest is much more moist. Just how to classify this section is difficult but there seems to be enough individuality in the wetter portion to classify this as a separate formation.

Some of the characteristic trees are the *Montezuma speciosissima, Hyeronima clusioides, Pleodendron macracantha, Coccolobis grandifolia, Diospyros ebenaster, Oxandra lanceolata, Quaribaea turbinata, Ceiba pentandra, Cedrela odorata, Pithecolobium arborea, Maba Sintenissii, Paralabatia portoricensis, Petitia domingensis, Cordia alliodora* and *Cornutia obovata.* Orchids, ferns, mosses, vines and other herbaceous plants are abundant as the type is very luxuriant, and is undoubtedly the formation richest in species of the seven. This is true of the palms also with the royal and coconut palms, the *Thrinax microcarpa* forming colonies on the cliffs, with *Bactris acanthophylla* at the base and on the slopes of the hills, and on the very summits, the slender trunks of *Quassia attenuata* are silhouetted against the sky.

Running southeastward from near Mayaguez on the western coast is a strip of serpentine rock which partly traverses the southwestern corner of the island. Like the previous limestone area, this section supports a mixed vegetation of dry-sited species mingled with those from wetter areas with the addition of certain species peculiar to the formation. Only further study will adequately settle the question as to whether or not this deserves full type status but it is so presented on the map.

The soft serpentine breaks down into a red clay very slippery in the wet season and very hard and dry in drought periods. The soil is lacking in phosphates and is little used for agriculture other than subsistence farming. Erosion is severe. Although adequate precipitation falls, the soil dries out rapidly and there is a long extended dry period in the winter months so that the type leans towards the drier vegetation.

Typical tree species of the formation are *Amomis grisea, Byrsonima cuneata, Mayepea domingensis, Tabebuia haemantha, Clusia rosea, Taonabo pachyphylla, Ilex guianensis* and an undescribed tree of the *Lauraceae.* Much of the area has been cleared by man or the forests might have been destroyed by fires which are common in this section making it difficult to find a true representative area of the formation. Brake ferns cover large areas of the cleared land.

With the serpentine formation we have completed a very brief sketch of the vegetation of the island of Puerto Rico, with mention of only a few of the many species but enough it is hoped to give a rapid glimpse of the conspicuous elements of each of the types listed here. The adjacent islands of Mona, Vieques, Culebra and a few smaller islets all fall within the dry lowland type with the largest island, Vieques, extensively denuded for agriculture and pasture and Culebra in a similar manner largely employed for grazing. Much further research will be needed before a clear cut ecology of the smallest of the Greater Antilles can be definitely known and each succeeding year finds the problem more difficult as the population of the island increases and the hand of man rests correspondingly heavier on the vegetation of the area.

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CLAUD L. HORN: **Plant Resources of Puerto Rico:** — Puerto Rico is the smallest and easternmost of the Greater Antilles. The movements of the trade winds and the rather constant water temperature of the Caribbean Sea to the south and of the Atlantic Ocean to the north of the Island give a leveling effect to the temperature which at equal altitudes is quite uniform at various parts of the Island. The older rock formations occupy the middle portion of the oblong island having an east-west axis. These lands reach a maximum elevation of almost 1,370 meters above the sea. The newer lands occur largely as limestone deposits forming the north and south coastal plains. Factors affecting the vegetation are mostly attributable to variations in elevations, rainfall and soils. An observer crossing the Island on one of the excellent highways readily notices the changes in vegetation due to these factors.

Moisture from the northeastern trade winds is precipitated in greatest amount in the National Forest of the Luquillo mountains in the northeast where the annual rainfall is approximately 5,080 millimeters. The central highland and the north coast have ample rainfall while the south coast receives from about 1,270 millimeters in the southeastern portion to about 508 millimeters in the southwestern portion of the Island. Consequently, the vegetation varies from tropical rainforest in the Luquillo mountains to xerophytic in the southwest.

The soils of Puerto Rico are in general not very fertile, and on the steep slopes over most of the Island, are thin. In 1939, 4,235,488 dollars were spent for fertilizers and manures for the total of 414,201 hectares* of cropland, most of the fertilizer being applied on sugar cane and tobacco land. Much of the coastal plains consist of alluvial deposited soils which are the deepest and most fertile. Sugar cane cultivation occupies most of this land.

Puerto Rico has many kinds of plants which are found naturally only there. None of these have been extensively developed as crop plants, although the endemic *Magnolia splendens, M. portoricensis* and *Stahlia monosperma* are valuable timber trees; while in certain districts *Phlebotaenia cowellii* with its cloak of violet-colored flowers seasonally adds to the beauty of the landscape.

* 1 hectare = 2.471 acres.

Most of the plant resources of Puerto Rico lie in those plants cultivated as crops. Therefore, the following description of the plant resources consists largely of data on the cultivated crops. Agriculture is by far the principal resource of the Island. For this one resource—in one of the most densely populated areas of the world—with only 414,201 hectares of cropland to support 1,869,255 people, it must attain a high degree of efficiency.

Of the total Island area of 887,017 hectares, about 84 percent is in a total of 55,519 farms. Approximately fifty-six percent of the area of these farms, or 414,201 hectares, is cropland. Eighty-three percent of the farms were less than 7.86 hectares each in size, while approximately 5 percent of them were larger than 39.32 hectares. Of the 414,201 hectares of cropland, 32,834 were in crops for future harvest, 290,897 were harvested; 23,651 were fallow; 28,641 were in crops which failed; while 38,178 were idle.

The number of hectares devoted to the principal specified fruit trees or plants was as follows in 1940: coffee, 71,217; bananas, 18,527; plantains, 6,597; grapefruit, 1,915; pineapples, 752; oranges 3,885; coconuts, 5,097. In addition the following numbers of fruit-bearing plants were cultivated; limes, 2,340; avocados, 287,197; mangos, 90,321; guavas, 39,145; cacao, 13,244; citrons, 15,090; vanilla, 127,839; breadfruit, 58,563; papayas 4,788.

The number of hectares of the following principal field crops harvested in 1939 were: sugar cane, 90,346 on 17.8 percent of all farms; tobacco, 11,240; corn, 23,339; rice, 5,408; cowpeas, 4,866; pigeon peas, 13,488; dry beans, 19,018; cotton, 1,330; sweet potatoes, 19,491; ñames, 3,471; yautia, 8,683; cassava, 2,594.

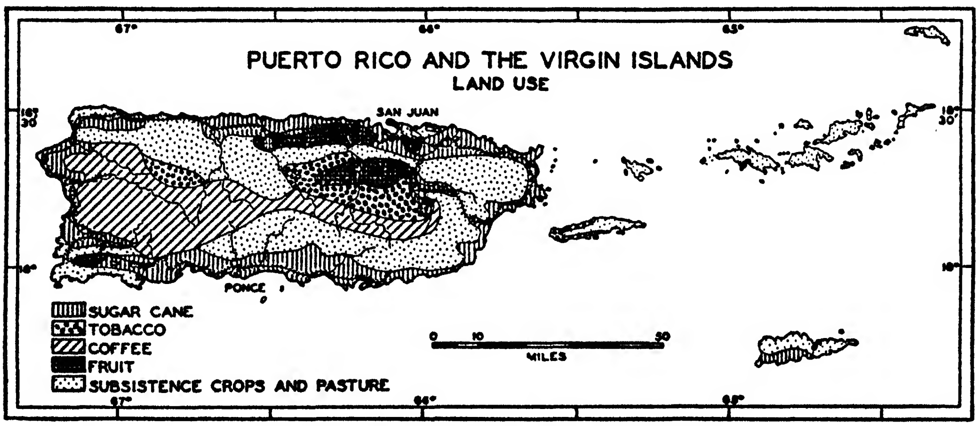
The number of hectares of the following principal vegetables harvested for sale in 1939 were: eggplant 131; squash (*Cucurbita moschata*), 467; onions, 159; green beans, 196; lettuce, 83; cucumber, 126; peppers, 332; okra, 78; cabbage, 237; tomatoes, 836.

In 1939, 60,162 hectares were in woodland pasture; 118,076 were in plowable pasture; 65,125 were in all other pastures; 51,872 were in other woodland; 32,158 were in unclassified uses.

The principal pasture grasses are guinea grass (*Panicum maximum*), Para grass (*Panicum purpurascens* and *Eriochloa polystachya*); molasses grass (*Melinis minutiflora*); Bermuda grass (*Cynodon dactylon*); and carpet grass (*Axonopus compressus*). Much Guatemala grass (*Tripsacum laxum*) and Napier grass (*Pennisetum purpureum*) are used as cut forage.

The common domestic fuel of the Island is charcoal. Much of the coffee shade thinnings and woodland are converted into the charcoal crop. The mangrove harvest from the government owned and operated coastal swamps is also a principal source of charcoal. Approximately 11,797 hectares are in the forests under the administration of the United States Forest Service, while approximately 19,665 hectares, including the mangrove swamps, are administered by the Insular Forest Service.

Some of the important forest tree species in Puerto Rico are: *Cedrela odorata, Dacryodes excelsa, Xanthoxylum flavum, Guaiacum officinale, Magnolia splendens, M. portoricensis, Montezuma speciosissima, Bucida buceras, Manilkara nitida, Tabebuia pallida, Stahlia monosperma, Ocotea moschata, Hymenaea courbaril, Andira inermis, Eugenia jambos,* and *Euterpe globosa.*




(*From* JAMES's Latin America, New York 1942)

The Agricultural Experiment Station and the Agricultural Extension Service, with headquarters at Rio Piedras, conduct research to develop better crops and crop practices and carry these to the farmer on his farm throughout the Island. The United States Forest Service Tropical Forest Experiment Station conducts forestry research at its headquarters at Rio Piedras and in the Island forest units. The United States Department of Agriculture Experiment Station at Mayagüez is the outstanding Western Hemisphere tropical agricultural research station. This station has energetically assembled the largest collection of tropical plants of economic value in this hemisphere for its program of investigations of various tropical crop plants and in its search for new crop plants for the Hemisphere.

OFFICE OF FOREIGN AGRIC. RELATIONS,
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of equal size in the world has been as adequately covered as the flora of Puerto Rico has been in this work.
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HENRI STEHLÉ: **Les Conditions Ecologiques, la Végétation et les Ressources Agricoles de l'Archipel des Petites Antilles:** — La végétation des Petites Antilles, luxuriante et variée sur un territoire restreint, est la conséquence de conditions édapho-climatiques les plus diverses et les ressources agricoles qu'elle permet sont le résultat des actions anthropozoïques, depuis les populations pré-colombiennes et caraïbes jusqu'à l'influence de l'homme civilisé, intensément manifestée, dans ces iles, depuis plus de 3 siècles.

## ESQUISSE GÉOGRAPHIQUE

Dans les Antilles ou Indes Occidentales, reliant de façon insulaire l'Amérique du Nord à l'Amérique du Sud, s'étend au Sud une série de petites îles, sur une ligne courbe de 2.000 km. de long, affectant la forme générale d'un fer à cheval ouvert vers la Mer des Antilles ou Mer Caraïbe, faisant suite aux Grandes Antilles, depuis Puerto-Rico jusqu'au Vénézuela, entre le 7ème degré et le 19 ème degré de latitude Nord. Ces Iles, qui paraissent sur les cartes une profusion de points ou de tirets, sont parfois de petits ilots mais aussi, pour certaines d'entre elles, des aires dépassant 3.000 km. carrés, offrant dans leur domaine la synthèse de végétations intertropicales variées et dont la propriété se partage entre trois nations européennes: la France, l'Angleterre et la Hollande et des possessions Sud-Américaines du Vénézuela, pour certaines Iles du Sud.

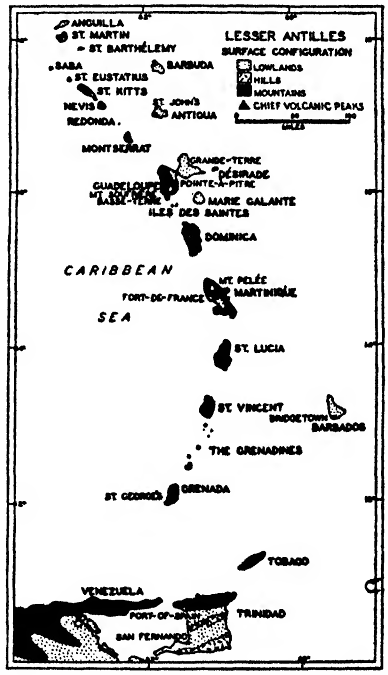
La plus au Nord est la petite Anguilla (A)*, la plus au Sud, et aussi la plus grande, est l'Ile de Trinidad (A)*, autrefois la Trinité; l'Ile de Barbados (A)* s'avance vers l'Atlantique alors que celle d'Aruba (H)*, près du continent Sud-Américain, est la plus à l'Ouest de tout l'archipel. L'on peut même y distinguer 3 entités géographiques distinctes:

**Les Iles du Vent: d'Anguilla à Grenada.**
**Les Iles Sous-le-Vent: de Margarita à Aruba.**
**Les Iles de Trinidad et Tobago, détachées de la Côte Vénézuélienne.**

*Les Iles du Vent.* — Ces iles, comprenant les unes des Antilles françaises comme la Guadeloupe et Dépendances et la Martinique, les autres de la série des "British West Indian Islands," se divisent topographiquement en Groupe Caraïbe Nord et Groupe Caraïbe Sud ou, d'après l'influence du vent dominant, en "Leeward" et "Windward Islands," ainsi dénommées sur les cartes anglaises et les relevés maritimes.

Les "Leeward Islands" ou "Groupe Caraïbe Nord," comportent, du Nord au Sud: Anguilla (A)*, St-Martin (F&H), St-Barthélémy (F)* (l'Ouanalao caraïbe), Barbados (A), Saba (H)*, St-Eustache (H), St-Christophe ou St-Kitts (A), Nevis (A), Antigua (A), Montserrat (A), Guadeloupe (F), la Désirade (F), les Saintes (F), Marie-Galante (F), Petite-Terre (F), et la Dominique (A). C'est l'île française de la Guadeloupe, la Karukéra des Caraïbes, qui, avec la Grande-Terre plate et la Basse-Terre tourmentée, est la plus grande de ces îles, occupant 1.500 km. carrés de superficie; la Dominique, possession britannique, est la plus élevée, le Morne Diablotin étant le point culminant de tout l'archipel avec 1.650 m. (5.200 feet).

Les "Windward Islands" ou "Groupe Caraïbe Sud," comprennent, en succession des précédentes: la Martinique (F), St-Lucia (A), Barbados (A), St-Vincent (A), Grenada (A) et les Grenadines (A), archipel secondaire formé de 6 îles: Bequia, Moustique, Cannouan, Union, Cariobacou (Carriacou) et la Ronde. C'est la Martinique (la Madinina des Caraïbes), la plus




(*D'après* JAMES's Latin America, New York 1942)

ample: 987 km. carrés et la plus élevée, au Mont-Pelée, alt. 1.450 m. (4.380 feet), de triste mémoire.

*Les Iles Sous-Le-Vent.* — Elles constituent une série d'îles relativement plus sèches, le long de la côte du Vénézuéla, dans la Mer Caraïbe: Margarita (V)*, Tortuga (V), Bonaire (H), Curaçao (H) et Aruba (H), ces 3 dernières forment le groupe des Indes Occidentales Néerlandaises.

*Les Iles de Trinidad & Tobago.* — De formation plus récente et détachées du continent voisin, ces Iles sont très rapprochées et la Trinidad, île anglaise ainsi que Tobago, est la plus grande de tout l'archipel des Petites Antilles; elle possède la végétation la plus riche et l'agriculture la plus évoluée.

## CONDITIONS ÉCOLOGIQUES

Les influences climatiques et édaphiques sont primordiales sur la végétation des Iles Caraïbes, tant sur leur richesse floristique ou les aspects physionomiques, constituant les communautés

* A. possession anglaise. — F. possession française. — H. possession hollandaise. — V. possession vénézuélienne.

végétales et les types forestiers, que sur leur agronomie et la répartition des différentes ressources tirées des plantes et des arbres.

*Facteurs Climatiques et Géophysiques.* — La pluviométrie est un facteur prépondérant tant par la hauteur d'eau moyenne recueillie que par la répartition mensuelle des pluies tombées. Ce qui caractérise l'archipel des Petites Antilles, à ce point de vue, c'est le passage du courant équatorial nord avec des masses énormes d'eau au niveau de la Dominique et dont les variations sont en liaison étroite avec celles des vents alizés. Les moyennes de chute pluviométrique décennales font ressortir en effet pour les 5 iles principales des archipels au Vent et Sous-le-Vent, la supériorité de la Dominique et le minimum pour Barbados, d'après l'ensemble complet des observations dans chacune des ces iles, conduisant aux chiffres: Dominique: 2.290 mm. (86 inches), Martinique: 2.269 mm. (85 inches), St-Lucia: 2.138 mm. (79 inches), Guadeloupe: 1.702 mm. (67 inches) et Barbados: 1.536 mm. (57 inches).

Par ailleurs, des grandes variations locales et annuelles sont à enregistrer dans chaque ile où il n'y a pas une concomitance obligatoire entre les maxima et les minima observés entre les iles voisines; il est à noter au contraire que le maximum de la Dominique coïncide avec le minimum de la Martinique et inversement. Cette dernière île recevant les brises du Sud de l'hivernage, la première recueillera l'humidité déchargée par les vents du Nord. Ainsi, la Dominique et la Martinique reçoivent un tiers d'eau en plus que Barbados, Cuba et Jamaica et environ le double de celle recueillie par les Iles Sous-le-Vent.

En moyenne, les mois de Mars et Avril sont les plus secs et ceux de Septembre et Novembre les plus humides. La sécheresse n'est généralement pas de longue durée et l'on distingue 4 saisons plus ou moins tranchées suivant les îles et les années: l'une de Décembre à Mars: sèche et fraiche, l'autre d'Avril à Juin: sèche et chaude, appelée "carême," auxquelles succède "l'hivernage," qui va de Juillet à Septembre et est humide et chaud et enfin une saison fraîche et humide, d'Octobre à Décembre. La floraison a lieu toute l'année, mais on observe un printemps végétal de Mars à Juin avec optimum en Mai, appelé "mois du renouveau."

La température oscille de 18 degrés à 35 degrés centigrades (64 degrés à 95 degrés Fahrenheit), elle est en moyenne de 25° C. (77° F.); elle est toujours plus élevée dans les iles basses ou au bord de la mer; dans les île élevées, les variations diurnes sont faibles, les plus grandes ayant lieu par les journées claires de Mars et d'Avril; son action sur la végétation et les cultures apparait secondaire. Par contre, l'humidité atmosphérique joue un rôle fondamental; si elle est assez irrégulière en humidité relative moyenne, elle est de variation très régulière dans l'année pour chaque île en humidité absolue ou tension de vapeur. L'évaporation est en général assez élevée et Fort-de-France par exemple, au centre de l'archipel, se présente parmi les climats humides comme un de ceux qui, dans le monde, possèdent une évaporation des plus élevées. Elle est maximum en Avril, minimum en Octobre et, en règle apparente, elle décroît régulièrement entre ces 2 époques de l'année pour croître à nouveau jusqu'à la fin de l'année. Dans l'intérieur des iles les plus boisées, elle est voisine de la saturation totale.

La pression atmosphérique offre dans toutes les Iles Caraïbes 2 maxima et 2 minima bien marqués; si le plus fort maximum varie avec le lieu, le plus petit minimum parait se placer généralement en novembre.

L'on peut distinguer dans l'archipel l'influence de 3 sortes de vents au sol: les alizés, dont la direction varie du Nord-Est au Sud-Est, qui soufflent de 80 à 90% de fois dans les iles centrales de l'arc, une 2ème catégorie groupant les vents côtiers, comme les brises de terre et les brises de mer ou les vents de turbulence causés par le relief et parcourant les pentes de montagne, enfin les vents accompagnant les perturbations cycloniques, qui se manifestent de Juillet à Octobre, avec maximum en Septembre; ces dépressions cycloniques se font sentir avec une grande intensité dans les îles de la Mer des Antilles et dans le Golfe du Mexique. Leur action est néfaste et parfois désastreuse sur la végétation et l'agriculture; tel celui du 12 au 20 Septembre 1928, dont le centre est passé le 12 sur la Guadeloupe, puis sur Puerto-Rico et a atteint le Sud-Est de la Floride, après avoir détruit une partie de Pointe-à-Pître et fait des dégats énormes dans les cultures vivrières et arbustives.

## OROGÉNÈSE, HISTOIRE GÉOLOGIQUE ET CONDITIONS ÉDAPHIQUES

A la diversité du climat correspond une diversité des sols, dans leur origine, leur stratigraphie, leur structure et leur désagrégation, non seulement dans les diverses iles des Petites Antilles, mais encore à l'intérieur d'une même île, aussi les types de végétation, principalement soumis à l'action du climat, présentent-ils des faciès plus particulièrement en liaison avec la constitution du sol; enfin, pour l'agriculture insulaire, la fertilité de la terre dérivée des différentes roches mères, permettra l'installation de cultures adaptées.

L'orogénèse et l'histoire géologique de ces iles, qui expliquent les conditions édaphiques, sont complexes. En résumé: le premier arc plutonique sous-marin formé émergea au-dessus des flots, puis fut dénudé et, sur ses flancs convexes, du côté intérieur, un nouvel arc fut élaboré, consistant en une rosette de volcans qui comprend l'arc volcanique des Petites Antilles. D'après ALFRED SENN, l'activité volcanique s'y continua depuis l'Eocène supérieur jusqu'à l'époque actuelle, complétant la sédimentation océanique par un apport énorme de cendres, laves, boues et nuages denses, qui combla la dépression située entre le nouvel arc d'origine ignée et l'anneau plutonique ancien. Ainsi, d'énormes épaisseurs de tuffs volcaniques se déposèrent dans la mer voisine, depuis l'Eocène jusqu'au milieu de l'époque miocène. La poussière volcanique la plus fine fut transportée jusqu'à l'île de Barbados, la plus à l'Est dans l'Atlantique où elle s'intercala aux couches de foraminifères et radiolaires déposées dans une profonde mer. Au Miocène-Pliocène, l'orogénèse Rhodanienne paraît avoir causé une nouvelle élévation de l'arc volcanique des Petites Antilles et une reprise de l'activité volcanique, confirmée par la nature subaérienne et la stratification des tuffs dans le cycle Oligo-Miocène. Des relations entre les régions antillaises et méditerranéennes semblent avoir existé le long de certains fonds géanticlinaux mettant en communication Curaçao et les Grandes Antilles. L'orogénèse Lamaridéenne

créa une première connexion entre les Grandes Antilles et les fonds de Curaçao par l'arc plutonique sous-marin des Petites-Antilles et c'est l'orogénèse Pyrénéenne qui causa l'émergence de cet arc ancien en créant, en outre, un nouvel arc volcanique sur le bord interne, celui des Iles Caraïbes. Grâce à lui, l'Amérique du Nord et celle du Sud furent reliées pendant l'Eocène supérieur; les communications antérieures Antillo-Méditerranéennes étant, par contre, rompues par la révolution Pyrénéenne.

Les analyses de roches ignées des 3 principales phases magmatiques des îles les plus diverses de l'archipel caraïbe sont en accord avec la loi de Kossmat, énoncée en 1936 et confirment le caractère homogène de la province magmatique des Petites Antilles, observé aussi bien par J. GIRAUD, le collaborateur d'A. LACROIX, en 1918, qui a reconnu aux roches volcaniques de la Martinique, une composition leur donnant un air de famille, que par W. VAN TONGEREN, en 1934, pour l'Ile d'Aruba. La première phase du cycle orogénique est en effet caractérisée par des intrusions sous-marines de laves basiques du type ophiolithique (Crétacé de Curaçao), la 2ème par l'apport de larges masses de minéraux volcaniques acides, surtout de diorites granitoïdes (Crétacé-Eocène de Curaçao et les Petites Antilles, type Martinique) ; la 3ème par la mise en place de roches éruptives le long des fissures et provenant des éruptions de l'Eocène supérieur (Curaçao) et de l'arc volcanique des Iles Caraïbes, depuis l'Eocène jusqu'à la période actuelle. L'acidité du sol, son vieillissement, sa perméabilité et sa fertilité sont en rapport étroit avec cette triple origine.

Les roches mères sont donc d'origine volcanique avec tuffs, basaltes ou labradorites (Guadeloupe et Saintes) ; andésites, dacites et dépôts meubles (Martinique), augite, andésites hypersthènes et basaltes noires recouvertes de brèches et conglomérats (St-Vincent, Dominique), cinérites et sédiments orogéniques, provenant de roches métamorphiques à veines quartzeuses et de roches ignées (Scotland, au Sud de Barbados) ; microgranulites (Nord Désirade) ; phyllites avec intercalations de calcaires cristallisés (Nord Trinidad), et roches ignées basiques; épidiorites, solerites et gabbros (plus de la moitié de Trinidad) ; diabases, porphyrites, tuffs et schistes foncés (Curaçao et Bonaire) ; avec des intercalations épaisses de diabases variées et de calcaires denses, gris foncés (Aruba) et elles offrent toutes, dans leur diversité, des parentés d'origine et de constitution expliquant, en dépit de leurs différences, le caractère homogène constaté dans l'ensemble des sols des Petites Antilles.

Les terrains sédimentaires présentent également des affinités de structure bien que leur âge soit différent: ce sont des calcaires de l'oligocène moyen et supérieur à la Martinique (Anse Macabou et Vauclin) et à Antigua, des roches aquitaniennes de l'Oligocène supérieur à Anguilla et les Grenadines (Carriacou) des calcaires pléistocènes à St-Eustache, Montserrat, Barbuda et Barbados et des "roches à ravet" du Miocène à la Grande-Terre à la Guadeloupe, les 6/7 de l'île de Barbados sont couverts de roches calcaires du Pléistocène, constituant les récifs coralliens, homologues des "mornes" du Nord de la Guadeloupe et du Sud de la Martinique et les conglomérats de Midden à Curaçao, sont les correspondants de la formation de Scotland de Barbados. Les calcaires à sédiments sableux ou coquilliers de Trinidad sont d'âge crétacé supérieur, les calcaires à rudistes de Curaçao sont de même âge ainsi que les couches à conglomérats calciques correspondantes de Bonaire, épaisses de 200 m.

L'érosion, avec une désagrégation éolienne, marine et fluviale par des rivières à caractère torrentiel, s'est superposée aux éruptions et sédimentations des dépôts marins, des alluvions, des laves désintégrées et des apports détritiques en ont résulté. Les facteurs climatiques et surtout la forte pluviométrie ont contribué à la désagrégation intense de ces roches mères, amenant la formation en surface d'hydrargiles et sols latéritoïdes divers, argileux et rougeâtres, qui, par rapport à la roche dont ils dérivent, sont caractérisés par la pauvreté en $SiO_2$, $K_2O$ et $P_2O_5$, la disparition de CaO et MgO et l'enrichissement notable en $Fe_2O_3$ et en $Al_2O_3$. C'est le "pays de l'ocre" de la Martinique. La couche arable qui en résulte sur sol découvert est très diluée et a une faible teneur en humophosphates alors que les sols sylvatiques sont humifères grâce à la protection réalisée par la forêt dense intertropicale, couvrant la partie centrale de la plupart des iles de l'archipel. Ces caractères expliquent la valeur moins élevée des sols volcaniques, auxquels on attribuait exagérément une énorme et inépuisable fertilité.

### LES TYPES PRIMITIFS DE LA VÉGÉTATION

Dans l'archipel des Iles Caraïbes, l'action combinée de la topographie locale, des facteurs définis du climat ou de la géophysique et des conditions orogénétiques, géologiques ou édaphiques, s'est manifestée sur la végétation pour permettre la formation de types forestiers primitifs constituant le climax, ensuite leur évolution et enfin, sous l'action de l'homme, leur régression, leur exploitation et l'installation de l'agriculture par substitution.

Une étude phyto-sociologique comparée des différentes îles, depuis Anguilla jusqu'à Aruba, permet de mettre en évidence des caractères communs incontestables dans l'aspect physionomique de la végétation, primitive ou secondaire et dans l'analogie des communautés et des successions. Suivant leur ampleur et leur altitude, toutes les Iles n'offrent pas obligatoirement tous les types forestiers primitifs, mais les plus amples comme Trinidad et les plus élevées comme la Dominique, la Guadeloupe et la Martinique, présentent chacune, en une admirable synthèse, dans leur optimum biologique, les types, sous-types et faciès de la végétation caraïbe. Chaque île, cependant, conserve une certaine entité floristique et sociologique de par son endémisme, ses zonations particulières et ses associations végétales.

On peut distinguer 5 types forestiers caraïbes fondamentaux, qui sont: la mangrove, d'origine plus spécialement édaphique, la forêt xérophytique ou xéro-héliophile, la forêt mésophytique ou intermédiaire, la forêt hygrophytique, dense, humide et polystrate et la forêt altitudinale ou sylve montagnarde culminale, des plus hauts sommets volcaniques.

*Mangrove.* — Cette forêt sur marécages marins, plus ou moins salins existe, avec ses caractères essentiels, dans la plupart des îles des Petites Antilles, à l'exception toutefois de la Dominique. Elle présente, suivant la salinité des boues, l'apport d'eau douce rivulaire, l'as-

pect et la composition floristique, deux faciès distincts:

(*a*) *Faciès maritime pantropical.* — C'est l'association homogène, halophile, à *Rhizophora Mangle-Avicennia nitida* des littoraux bas, vaseux et semi-liquides de l'archipel caraïbe, en état d'équilibre biologique, elle est l'homologue de la mangrove des estuaires antillais et sud-américains, ainsi que de ceux de la Côte Occidentale d'Afrique ou du Sud-Asiatique. Elle occupe 3,6% de la surface totale de la Guadeloupe, 8% de la Grande-Terre, 2% de la Basse-Terre, 1,8% de Marie-Galante et 2,5% de la Martinique. Les 2 autres palétuviers caractéristiques qui l'occupent sont, en outre du *Rhizophora* et de l'*Avicennia*, le *Conocarpus erecta* et le *Laguncularia racemosa;* d'autres électifs sont *Drepanocarpus lunatus, Montrichardia arborescens, M. aculeata* et diverses lianes des marais: *Rhabdadenia biflora, Cydista aequinoctialis, Brachypteris borealis* et quelques rares espèces herbacées lorsque les boues semi-fluides deviennent fermes. L'aspect branchu, à type foliaire microphylle des végétaux électifs, leur reproduction particulière par viviparité (*Rhizophora*), la présence des "pneumatophores" ou racines aériennes servant à la fonction diastasique ou respiratoire (*Avicennia*), la rapidité de germination des graines dans la vase de ces différents "mangliers" sont autant de caractères particuliers de cette formation maritime.

(*b*) *Faciès rivulaire antillais.* — C'est la forêt à *Pterocarpus officinalis*, à grands arbres élevés, éperonnés à la base de contreforts puissants, installée sur sédiments alluvionnaires peu salins, le long des rivières d'eau douce. Son aspect rappelle certains faciès de la forêt intérieure. La dominance physionomique du *Pterocarpus* est, suivant les îles, de 50 à 95%. Les électives sont en outre: *Pavonia scabra, Clusia rosea* et *Drepanocarpus lunatus,* comme pour l'autre faciès. Des épiphytes couvrent les arbres: *Trichomanes Hookeri* et *Cereus trigonus* ou des lianes: *Mucuna Sloanei, Montrichardia* et *Philodendron.* Elle n'existe pas à la Martinique, mais se trouve à la Dominique et à Trinidad. Elle est à type foliaire mésophylle, de belle futaie, de 30 à 35 m. de haut et la présence de certaines espèces rares ou endémiques, comme l'*Hibiscus bifurcatus* et *Ptychomeria Germaini*, à la Guadeloupe, dans son optimum biologique, lui confèrent un caractère caraïbe spécial.

*Forêt Xérophytique ou Xéro-Héliophile.* — Les facteurs du climat agissant intensément sur la végétation littorale, surtout par l'insolation, la sécheresse et l'évaporation, constituent l'ambiance favorable, autour de chaque île des Petites Antilles, à une forêt xérophytique qui, suivant la topographie et la constitution du sol, offre différents faciès. Le caractère de la végétation forestière qu'elle présente, épineux ou inerme et à feuilles caduques, permet la différenciation en 2 sous-types distincts:

(*A*) *Forêts à épineux.* — Lorsque la pluviométrie oscille entre 0m.60 (22 inches) et 1m.50 (55 inches) en moyenne annuelle et lorsque la luminosité et l'évaporation sont accentuées, la forêt à épineux, à *Acacia,* dont les espèces varient dans le genre avec les Iles et les secteurs, est la plus élective des rivages insulaires. Les légumineuses arbustives et à folioles microphylles, à xérophilie accentuée: *Acacia, Sophora* et *Cactus* variés, y dominent floristiquement et lui impriment son cachet particulier, depuis Curaçao jusqu'à St-Martin, aux altitudes les plus basses.

(*B*) *Forêts à caducifoliés.* — De 1.500 à 1.800 mm. d'eau (55 à 65 inches), avec une température de 25 degrés C. en moyenne, sans variation accentuée, les épineux sont remplacés par une forêt dont la dominance est constituée par des arbres caducifoliés, à xéro-héliophilie moins accentuée, mais nettement manifestée par la production de sucs colorés et visqueux, de vaisseaux laticifères et de sécrétions aromatiques diverses dans les tissus, par la microphyllie du type foliaire, avec limbes couverts de revêtements pileux abondants, par l'exfoliation périodique de plaques d'écorce du tronc et des feuilles, ce qui réduit l'évaporation du végétal pendant les mois les plus secs. D'après la structure, l'épaisseur et la perméabilité du sol sur lequel elles poussent, trois faciès comportant des associations différentes peuvent être distingués:

(*a*) *Faciès psammophile sur sables.* — L'on pourrait certainement distinguer la végétation climaxique des sables blancs de décomposition de récifs coralliens ou de calcaires sédimentaires, des sables noirs à pyroxène, hypersthène ou andésite, mais l'état physique du substratum joue certainement sur la végétation un rôle plus efficace que la structure chimique. C'est en général une forêt à "poiriers des Antilles" ou "roble," à *Tabebuia pallida*, à "fromager:" *Ceiba antillana*, ou à mancenilliers: *Hippomane mancinella* et à sabliers: *Hura crepitans.* On décompte de 80 à 100 arbres à l'ha., à futs élancés, à feuilles coriaces, vertes et brillantes et à 2 à 3 floraisons par an.

(*b*) *Faciès calciphile sur sédiments.* — Sur les sols sédimentaires, à calcaires d'âge varié, s'intercalant souvent avec les tuffs volcaniques, des communautés végétales peuvent être différenciées suivant la localisation, mais l'influence édaphique (perméabilité) et la xérophilie du secteur se traduisent par un faciès analogue. C'est tantôt la forêt à *Krugiodendron ferreum-Forestiera rhamnifolia* (Martinique), celle à *Drypetes* (de Marie-Galante, homologue de celle d'Haïti), à *Bucida buceras* (des mornes calcaires à "roches à ravet" de la Grande-Terre en Guadeloupe, équivalente de celle de Puerto-Rico), et tantôt celle à *Amomis caryophyllata* et *Cornutia pyramidata* (à Vieux Fort, en Guadeloupe, sur les calcaires lenticulaires), à *Pisonia-Rhacoma* de Marie-Galante, ou celle à *Canella Winterana* (de la Désirade et d'autres petites îles sèches et calcaires). Les arbustes de ce faciès sont à feuilles très petites, luisantes et coriaces, leurs fruits drupacés réduits, leur bois dur, leur tige abondamment branchue et leur aspect rappellent singulièrement le paysage méditerranéen de la garrigue à arbustes rhamnoïdes, du Midi de la France, du maquis Corse ou du littoral d'Afrique du Nord.

(*c*) *Faciès volcanique sur roches ignées.* — Sur les "mornes" littoraux, basaltiques ou labradoritiques, des Saintes, de la Guadeloupe et de la Dominique, sur les collines peu élevées de roches dioritiques de la Martinique et dans la plupart des autres îles de l'archipel, le faciès volcanique de la forêt xérophytique s'observe avec la dominance du "gommier rouge:" *Elaphrium Simaruba*, avec les genres: *Fagara, Myrcia, Eugenia, Coccoloba* et *Cytharexylon*, d'espèces différentes ou semblables dans les diverses îles. Les *Pilocarpus racemosus, Colubrina reclinata, Maytenus elliptica, Actinostemon concolor* var. *caribaeum*, *Erythroxylon ovatum, Guettarda parvifolia* et *G. scabra, Amyris elemifera* et *A. maritima, Croton corylifolius, Rochefortia cuneata, Eugenia ligus-*

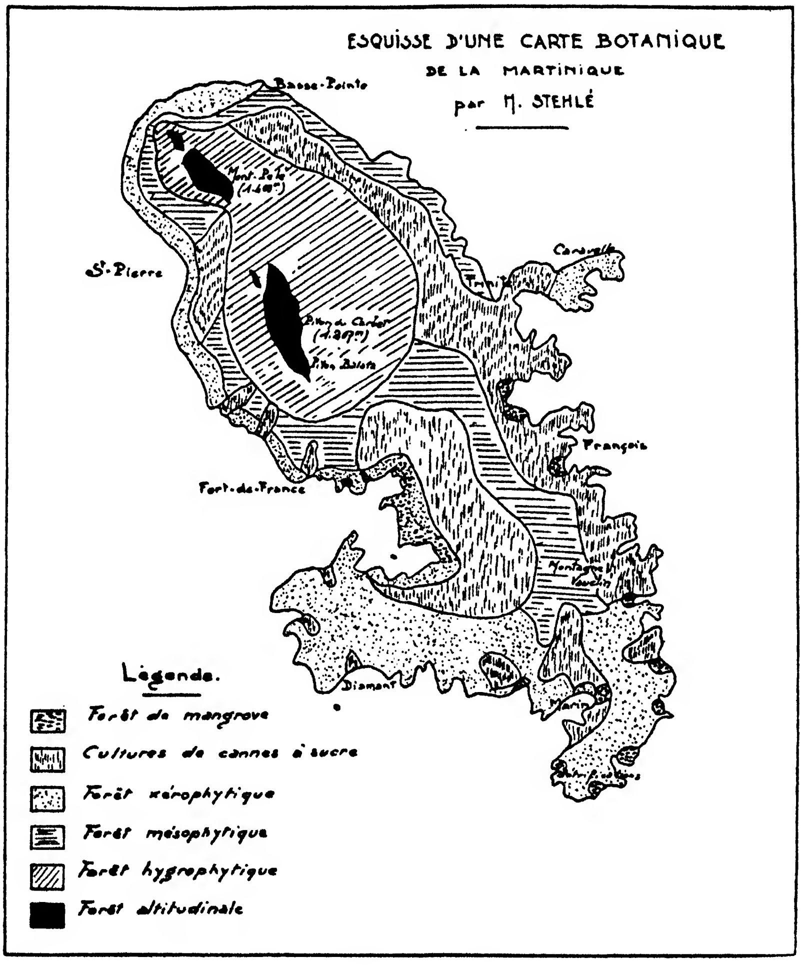
*trina, Fagara trifoliata* et *Homalium racemosum,* sont parmi les espèces arbustives les plus électives de ce faciès.

La xérophilie se manifeste par des caractères comparables à ceux du faciès calcaire: sucs résineux, pigments anthocyaniques et chute des feuilles. Elle se traduit même sur les cryptogames qui sont des lichens saxicoles, des muscinées terricoles à structure xérophile, des hépatiques plaquées (*Riccia*), dont l'aspect évoque celui du paysage bryophytique méditerranéen et des Iles du Cap-Vert.

*Forêt Mésophytique ou Intermédiaire.* — La pluviométrie s'accentuant en barême progressif

(*a*) *Faciès calciphile ou argileux.* — Sur les plateaux intérieurs des calcaires miocènes de la Grande-Terre, en Guadeloupe et sur les formations sédimentaires d'origine océanique de Barbados, dans le district de Scotland, on observe une forêt mésophytique assez comparable par son aspect à celle qui couvre les sols volcaniques de même altitude en Martinique, Dominique et Trinidad, mais en général à espèces électives différentes.

Dans l'Ile de Barbados, elle présente son optimum dans les bois de Turner's Hall ou de Forster Wood et, à un degré moindre, sur les reliefs calcaires de Highland Gullies of Mount




vers l'intérieur des îles, depuis 1m.80 (65 inches) à 2m.50 (90 inches) ou 2m.80 (100 inches) de hauteur d'eau, dès l'altitude de 120m. jusqu'à 300m. environ (400 à 1.000 feet), la forêt observée possède un type nettement différent des faciès xéro-héliophytiques précédents. Elle présente un aspect plus verdoyant, des arbres plus abondants, à la fois à feuilles persistantes et à feuilles caduques, l'apparition des lianes, épiphytes, fougères et orchidées, enfin la présence de plusieurs strates: muscinale, herbacée, suffrutescente, buissonnante et arborescente. Elle offre 2 faciès distincts, l'un sur dépôts marins sédimentaires, l'autre sur roches plutoniques:

Tabor. Le substratum est caractérisé par des conglomérats gris foncés de sables coquilliers traversés de bandes verdâtres d'argiles denses, à nodules ferrugineuses nombreuses, rouges ou brunes, provenant de la décalcification. L'humus est peu abondant à la surface. C'est une forêt *à Simaruba-Cedrela* avec *Schoepfia Schreberi, Ardisia humilis, Cestrum nocturnum, Fagara caribaea, Aiphanes minima* (palmier épineux), *Piper MacIntoshii* Trel. (nov. spec.) et *P. Eggersii* et *Clusia Pluckenetii,* avec une Aroïdée terrestre: *Anthurium Wildenowii,* un tapis herbacé ras, de *Salvia occidentalis,* une graminée lianoïde à masses filiformes denses, enchevê-

trées et élevées le long des arbres: *Lasiascis divaricata,* une liane très élevée à fleurs en grappes violettes: *Elsota diversifolia,* des fougères et broméliacées épiphytes: *Polypodium Phyllitidis, P. piloselloides* et *Wittmackia ligulata* etc.

Ces reliques, vestiges d'une plus belle forêt dans l'île très cultivée de Barbados, sont à comparer à ceux de la forêt à acajou-blanc de la Guadeloupe ou bois-blanc de Martinique à *Simaruba amara* et à celle à *Inga,* de plusieurs espèces différentes suivant les diverses îles antillaises. La forêt à *Carapa guianensis* de Trinidad appartenant aux "Monsoon forests" paraît appartenir à ce type. Les bois à *Buchenavia capitata,* à *Ficus* sp. pl. et à certains *Clusia,* sont à ranger dans ce faciès. Les espèces sont les unes caducifoliées, les autres sempervirentes et persistantes, mais leur type foliaire est nettement mésophylle et plusieurs sont à limbe épais, ferme ou charnu. Certains palmiers sont électifs: *Roystonea, Acrocomia aculeata* et *Cocothrinax martinicensis,* ainsi que des Pipéracées: *Piper calciseligens* et *P. dilatatum* var. *calcicolens.*

(*b*) *Faciès volcanique.* — Sur les labradorites des Saintes, sur les andésites peléennes du Nord de la Martinique, surtout entre Céron et Grand' Rivière, au sommet des mornes basaltiques du Houëlmont et de Deshaies, en Guadeloupe, sur les pentes volcaniques de St.-Lucia et de St.-Vincent, la forêt à angelin-savonnette: *Andira inermis* et *Lonchocarpus latifolius,* est l'équivalent du faciès précédent avec le même caractère mésophytique. Les arbres électifs sont nombreux et variables avec les îles et les secteurs dans la même île, l'hétérogénéité de la communauté étant assez grande. Les Légumineuses y dominent: *Lonchocarpus violaceus* et *L. Benthamianus, Hymenaea Courbaril* accompagnent les 2 plus électives avec diverses espèces des genres *Mayepea, Cordia, Exostema, Fagara,* etc., et, dans le sous-bois, des Piperacées suffrutescentes: *Piper Nottirbanum, P. Andersonii, P. Dussii* et *Pothomorphe Dussii.* Les mêmes épiphytes que pour le faciès précédent pourraient être citées, avec des mousses leucobryées et d'autres fougères: *Paltonium lanceolatum, Elaphoglossum Dussii* et *Polytaenium Dussianum,* équivalent insulaire de *P. brasiliense.*

*Forêt Hygrophytique ou Hygro-Sciaphile.* — C'est une forêt dense, intertropicale, humide, umbro-sciaphile, sempervirente et polystrate, établie sur montagne, entre 300m. et 900m. d'altitude (1.000-3.000 feet). Elle offre des analogies physionomiques marquées entre les diverses îles, qui, cependant, en raison des particularités topographiques et écologiques, microclimatiques et édaphiques, possèdent une personnalité floristique différente et une prédominance spécifique variée, dans ce type de forêt, permettant la distinction d'associations nombreuses.

L'étude approfondie de cette forêt pendant 10 ans, avec relevés floristiques, en liaison avec le climat et le sol, en Guadeloupe et en Martinique et l'examen comparatif des descriptions qui en ont été données ces dernières années dans les autres îles principales, nous permettent d'en distinguer 2 faciès, suivant qu'elle est établie sur sol varié mais toujours recouvert d'humus ou qu'elle est en terrain alluvionnaire, gorgé d'eau et mal drainé. Les termes anglais de "rain forest, moist forest, evergreen forest, lower and higher montane forest, mesophytic vegetation of the mountain interior, protection forest," qui lui ont été appliqués à Trinidad, la Dominique et St-Lucia, s'appliquent à des aspects locaux de ces 2 faciès de la forêt hygrophytique caraïbe.

Dans certaines îles, comme en Dominique, à la Guadeloupe et en Trinidad, elle occupe de vastes étendues, dont les parties centrales constituent un noyau primaire et il en est de même dans d'autres iles insuffisamment explorées encore écologiquement, comme St.-Kitts, St.-Lucia et St.-Vincent, mais elle n'existe pas, en raison de l'altitude et de la pluviométrie inférieures, dans les autres îles, plus petites ou plus plates, même en Barbados et à Curaçao. Elle est l'homologue de la forêt de Puerto-Rico, décrite par GLEASON et COOK, d'Haïti nommée par CIFERRI et de Cuba, étudiée par les Frères MARIE-VICTORIN et LEÓN; c'est le correspondant insulaire de "l'Hylea" d'Amérique Centrale ou du Sud, de POLAKOWSKY, dont l'ensemble constitue un "udophytia."

(*a*) *Faciès humifère.* — Quelle que soit l'orogénèse ou la constitution physico-chimique des roches mères à la base des sols forestiers caraïbes, l'humus que la forêt installée a formé elle-même, à la surface, par décomposition organique, a permis une analogie de milieu, renforcée par l'hygrométrie élevée et l'atténuation de la lumière que provoquent les frondaisons, branches et tiges, des gros arbres qui la constituent. A travers cet humus, le drainage de l'eau en excès peut s'effectuer, aussi, les végétaux qu'elle recèle sont-ils soutenus par des empâtements, mais non par des racines ou béquilles aériennes. Elle est caractérisée par son hétérogénéité générique et spécifique, en dépit d'une physionomie homogène à travers l'archipel et d'une communauté générique élevée pour les diverses îles, par le grand nombre des hauts arbres (jusqu'à 35 à 40 m. de haut, soit 100 à 125 feet), puissants, espacés (60 à 100 à l'ha.) et empâtés à leur base, à type foliaire macrophylle; par la superposition des strates avec des épiphytes phanérogamiques: Broméliacées, Pipéracées et Orchidées, ou cryptogamiques: fougères, mousses et lichens, abondantes et variées. Les fougères arborescentes lui donnent parfois, avec les aralies arbustives, un aspect particulier. Enfin, les cimes, arrondies ou infundibuliformes, des arbres élevés couvrent celles des arbres de 2ème grandeur, elliptiques ou des arbustes allongés et branchus. Elle est toujours verte et à 2 floraisons par an, l'une intense vers Mai, l'autre moins abondante en Décembre.

C'est une forêt à *Sloanea-Dacryodes* dominants dans l'ensemble; phytosociologiquement on pourrait la dénommer *"consociation à Sloanea."* Ces deux arbres sont à la fois les plus gros et les plus nombreux dans l'Archipel, mais la flore insulaire fait apparaitre des dominants différents, non seulement avec chaque île, mais encore à l'intérieur d'une même île, suivant l'altitude et la topographie.

A la Guadeloupe, où nous l'avons décrite en détail sans la désigner par les dominants en association vue son hétérogénéité, on pourrait la nommer forêt à *Sloanea-Chymarris,* mais les essences dominantes sont par classes juxtaposées, telles que: *Richeria grandis,* en Forêt de Fumée; *Sloanea caribaea* et *Dacryodes excelsa,* en Forêt des Bains-Jaunes; *Eugenia octopleura,* dans les hauteurs Sous-le-Vent, *Chymarrhis cymosa,* en Forêt de Terre-Plate; *Podocarpus coriaceus, Meliosma Herbertii,* dans le Haut-Matouba, etc., qui constituent autant de communautés élémentaires distinctes, avec des électives semblables

mais des dominantes différentes, dans ce même faciès humifère de la forêt hygrophytique.

Dans les autres îles, une distinction identique peut être conduite, après un examen attentif. En Dominique, la forêt décrite par DOMIN comme à *Sloanea-Dacryodes,* possède, d'après HODGE, plusieurs associations: *Tapura-Dacryodes, Licania*-dominant, et palmiers: *Euterpe-Geonoma.*

Pour la Martinique, nous l'avons décrite comme *Sloanea-Oxythece,* mais en basse altitude, c'est l'*Ormosia monosperma* qui domine en bordure; au centre de la chaine ce sont des Sapotacées: *Pouteria, Manilkara* ou *Chrysophyllum;* sur les falaises inaccessibles, le *Dussia martinicensis,* espèce endémique des Antilles françaises d'un genre présentant une intéressante disjonction caribéo-guatemaltèque; le *Chymarrhis cymosa* et le *Picramnia pentandra,* dominent en forêt humifère des Deux-Choux; le *Symplocos martinicensis,* au Morne Larcher et à Balata; le *Tapura antillana,* à Colson; enfin le *Phoebe elongata,* dans les hauteurs volcaniques Sous-le-Vent, dans les bois élevés du Prêcheur au Céron, en Martinique, comme sur les mornes basaltiques du Houélmont et des Monts Caraïbes, en Guadeloupe.

Dans l'Ile de St-Lucia, elle est, d'après WALD, à *Dacryodes hexandra* dominant, accompagné d'*Ocotea, Mimusops, Vitex,* etc., comme dans les autres petites îles voisines: Grenade et St-Vincent, mais il serait possible aussi d'y distinguer des classes différentes et des taux de présence variables.

Dans la grande île de Trinidad, les associations à *Mora excelsa* et surtout à *Licania ternatensis, Byrsonima spicata,* avec 17% de Légumineuses seulement, ou à *Eschweilera-Ternstroemia,* décrites par MARSHALL, puis par J. S. BEARD, sont, comme l'a fait judicieusement remarquer ce dernier auteur, très affines, physionomiquement et floristiquement, de celles de la Guadeloupe, comme d'ailleurs des autres grandes îles de l'Archipel: Sur 34 espèces que nous avions citées pour la Guadeloupe, il en a trouvé 9 dans la forêt type de Trinidad et presque tous les genres sont en commun. Il y a là une preuve de l'unité physionomique et de la similitude floristique dans l'Archipel de ce type de forêt hygrophytique.

Le sous-bois, bien que varié, est le plus souvent à Rubiacées arbustives dominantes: *Psychotria* et *Cephaelis,* avec un tapis cryptogamique à *Selaginella* et fougères abondantes; les épiphytes variées y abondent.

(*b*) *Faciès marécageux.* — Dans les terrains mal drainés, d'infiltration d'eau abondante, le long des vallées humides, dans les bas-fonds, les cuvettes et les thalwegs, aux abords des sources, étangs et marécages de l'intérieur des îles, entre les mêmes altitudes que l'autre faciès et dans des conditions semblables de climat, sur alluvions accumulées, terres gorgées d'eau, boues ou même sols semi-fluides, on observe un faciès de forêt semi-inondée où les arbres sont munis de racines aériennes, érigées, arquées ou éperonnées, imprimant à cette forêt une physionomie particulière.

Elle ne paraît pas avoir été décrite encore et elle existe cependant dans la plupart des Iles Caraïbes, de Trinidad à St-Kitts. Nous l'avons observée à la Guadeloupe, à la Dominique et à la Martinique; ses espèces électives figurent aussi dans les relevés de BEARD pour la forêt sempervirente de Trinidad. Elle est constituée par des "palétuviers ou mangliers de montagne," ainsi dénommés par analogie avec les mangliers de la mangrove qu'ils rappellent par leur aspect et le substratum. C'est une forêt à Guttifères dominantes: *Symphonia globulifera* ou palétuvier jaune, en Guadeloupe, où il constitue, en peuplement presque pur (60-90%), les forêts inondées de l'Etang Zombi, du Grand Etang, de la Jaille, du Tabanon à Petit-Bourg et du Valkanaerts à Gourbeyre, entre 50 et 850m. (160-2.750 feet) d'altitude et *Tovomita Plumieri,* palétuvier grand bois, en Martinique, dans les Vallées du Lorrain, les bas-fonds des Deux-Choux et de Colson, entre 450 et 850m. (1.450-2.2750 feet); en association à *Symphonia-Tovomita,* à la Dominique, avec d'autres électives. Parfois, c'est une forêt à dominance d'*Amanoa caribaea,* palétuvier gris ou palétuvier-carapate, comme au Bassin-Bleu, dans les hauteurs Sous-le-Vent, de Pigeon et de Bouillante et le long de la Vallée St-Louis, à la Guadeloupe. Le mapou-baril de Guadeloupe, mahot-cochon de Martinique et mahoe de Trinidad, est, dans la plupart des forêts de ce faciès, dans les diverses îles, une élective toujours présente, c'est le *Sterculia caribaea.*

A Trinidad, un type à *Carapa-Palmae,* cité par BROOKS, sur "swampy flats of mixed rain forest," présentant comme arbres dominants: *Carapa guianensis* et *Symphonia globulifera,* avec plusieurs espèces de palmiers: *Manicaria saccifera* et *Jessenia oligocarpa,* est l'équivalent de ce faciès. Le *Tovomita Eggersii,* wild cocoa, est l'homologue trinitéen du *Tovomita Plumieri,* de la Martinique et de la Dominique, dans ce faciès, et les autres électives ou compagnes sont des espèces communes avec la forêt humifère décrite, mais les plus hygrophytiques et celles qui tolèrent le mieux les eaux stagnantes au contact de leurs racines et du collet, en constituent les caractéristiques et présentent des phénomènes de convergence apparents.

*Forêt Altitudinale ou Sylve Montagnarde Culminale.* — Entre 850 et 1.650 m. (2.750-5.200 feet) d'altitude, aux plus hauts sommets des Iles Caraïbes, s'étend une forêt basse dénommée par SCHIMPER "Elfin woodlands", à Trinidad, Martinique, Dominique, Guadeloupe et St.-Kitts, où le vent violent, la fraicheur, les nuages et les pluies d'orage agissent et dans laquelle on peut reconnaître 3 faciès distincts: alluvionnaire, volcanique et culminant. La pluviométrie y oscille de 6m. à 10m. d'eau par an (220-360 inches), en trombes continues, sur 300 à 350 jours de pluie annuellement; les vents y soufflent avec une extrême vigueur, la température s'y abaisse notablement. L'atmosphère y est brassée constamment et l'on observe là, comme nous l'avons indiqué pour la Guadeloupe et la Martinique et BEARD pour Trinidad, le rabougrissement des arbres et la sécheresse physiologique de la végétation élective.

Les arbres sont bas, très branchus, touffus et buissonnants, mal définis dans leur forme, à feuilles en rosettes aux extrémités des branches. L'endémisme insulaire y présente un maximum.

(*a*) *Faciès alluvionnaire à palétuviers de montagne.* — C'est un *Clusietum* génériquement et physionomiquement, mais à espèces dominantes particulières. Il couvre les bas-fonds abrités et les pentes constamment arrosées, parfois couverts de détritus alluvionnaires et de boues accumulées sous les racines aériennes en échasse, en lacis enchevêtré et avec un abondant chevelu de fixation, ce qui lui imprime un pay-

sage comparable à celui du faciès précédent de la forêt hygrophytique ou de la mangrove littorale. Le développement des épiphytes corticicoles y est facilité par l'ombrage et le calme de l'atmosphère, mais les épiphylles y sont rares.

C'est le *Clusietum guadeloupense* à *Clusia venosa*, avec une dominance de 65 à 90%, avec 33 autres électives citées en 1936 dans notre Ecologie, et non en groupements pratiquement purs, comme l'indique W. H. Hodge par erreur (Geographical Review, New York, vol. XXIII, n. 3, p. 374, Juillet 1943). Les peuplements purs sont l'exception, les seuls où la dominance atteint 90%, vérifiée à nouveau, sont ceux de la Savane à Mulets, à la base de la Soufrière et des Pitons de Bouillante, en certains secteurs topographiquement bien abrités. Le *Freziera elegans* ou bois-savane et divers *Cephaelis*, caféiers de montagne, dont le *C. Swartzii* y figurent. Parmi les plus constantes et abondantes sont: le *Cyrilla racemiflora*, le *Myrcia microcarpa*, *M. Dussii* et l'*Inga coruscans*.

Le même *Clusietum*, avec la même espèce, ne présenterait en Dominique, d'après Hodge, qu'une demi-douzaine d'espèces pro-éminentes de petits arbres, les mêmes que celles des autres îles de la forêt à mousses des Petites Antilles. Ce "Kaklin" y serait la formation culminale ultime (mountain-top), alors qu'en Guadeloupe, il est au contraire dans son optimum biologique (90% de dominance), dans les thalwegs et les pentes abritées, mais non sur les sommets et pics volcaniques balayés par le vent, où poussent les palmiers *Euterpe*. Le *Clusietum dominicense*, ainsi que nous le désignerons, a donc, semble-t-il, certaines particularités biologiques et physionomiques distinctes du *Clusietum guadeloupense*, étroitement homologue.

Les vapeurs sulfureuses ont sur le *Clusietum* une grande influence destructive, observable à la Soufrière de la Guadeloupe, à la limite supérieure de leur formation.

En Martinique, la Montagne Pelée et les Pitons du Carbet offrent l'homologue, par le *Clusietum martinicense* à *Clusia Pluckenetii*, aralie z'abricot ou mangle de montagne, dominant de 60 jusqu'à 100% suivant les cas et qu'on retrouve à St-Lucia et, à plus basses altitudes, au Turner's Hall, en couronnement supérieur des sédiments recouverts par la forêt mésophytique.

A Trinidad, l'espèce principale de ce faciès, citée par Beard, en Janvier 1942, est la "mountain-mangrove:" *Clusia intertexta*, qui domine à raison de 90%, dont il précise les électives particulières et dont l'ensemble constitue un *Clusietum trinitense*, différent floristiquement mais très comparable à ceux décrits pour les Antilles françaises.

Le type foliaire de Raunkiaer, appliqué à ces *Clusieta*, les classe dans les séries mésophylles.

(*b*) *Faciès volcanique à forêt rabougrie.*— Le long des pentes les plus élevées et des pics volcaniques dressés, sur le sol dont les éléments utiles ont été entraînés par l'érosion dans les vallées avoisinantes, sous l'action d'une aération intense et des vapeurs sulfureuses, les *Clusieta* laissent place à une sylve basse, rabougrie, où le type foliaire mésophylle des arbrisseaux de la mangrove d'altitude du *Clusietum* est remplacé par le type microphylle, évoquant certains faciès volcaniques de la forêt xérophytique (à Myrtacées par exemple).

Ce faciès de la forêt altitudinale, très muscicphile et épiphytique, trouve son optimum sur les plus hauts sommets de St-Kitts, Guadeloupe et Martinique. Il a été décrit par Box (in Box et Alston), sous le nom d'association à *Freziera-Weinmannia*, qu'Hodge classe dans le *Clusietum*, mais dont la physionomie, la spécificité et l'aspect microphylle du type foliaire, placent incontestablement dans ce faciès, décrit en 1936, pour la Guadeloupe, sous le nom de *Lobelietum guadeloupense* des hautes altitudes à *Lobelia guadeloupensis-Didymopanax attenuatum*, et en 1937, pour la Martinique, sous celui de *Lobelietum martinicense* du faciès à *Rondeletia martinicensis-Lobelia conglobata*. Le *Rondeletia stereocarpa*, de la Guadeloupe, le *R. arborescens* de la Dominique, en sont les homologues dans les associations insulaires correspondantes de ce faciès martiniquais. Le *Freziera cordata*, bois d'épice, et le *Weinmannia pinnata*, bois siffleur, figurent tous deux parmi les plus électifs, dans nos relevés de la Guadeloupe (Essai d'Ecologie) et de la Martinique (Esquisse des Associations végétales). *Didymopanax attenuatum*, *Ilex montana* et *I. Macfadyenii* var. *caribaea*, *Norantea spiciflora* et *Tibouchina strigosa*, à la Guadeloupe, *Miconia martinicensis*, *Charianthus nodosus* var. *crinitus* et *Tibouchina chamaecistus*, à la Martinique, sont les plus électifs de ce faciès. Le *Tibouchina chironioides*, que le R. P. Duss (Fl. Ph. Ant. fr., p. 288) a récolté aux environs de Laudat (n. 2.251), non loin des Mornes Microtin et Watt, possédant cette forêt rabougrie, est le représentant dominiquais des deux espèces précédentes.

(*c*) *Faciès culminant à palmeraie basse.*— Persistant avec quelques rares caractéristiques au-dessus de la strate muscinale supérieure ou du *Sphagnetum*, la forêt de palmiste bas à *Euterpe globosa*, à la Martinique, la Dominique et la Guadeloupe, forme, comme à Puerto-Rico (palm forest) et en Haïti (manacle ou manaclar), des palmeraies basses, dont la présence se décèle par un sifflement caractéristique sous l'action du vent. Le sol très acide, le vent violent, l'influence des cyclones et l'absence d'ombrage sont les conditions d'extension de ce faciès en Guadeloupe, à l'Echelle et en Martinique aux Pitons du Carbet. En Dominique, au Morne Diablotin, alt. 1.400 m. (4.500 feet), il est associé avec *Geonoma dominicana* ou yanga et *G. Hodgeorum* sous 7m. 620 (280 inches) de pluviométrie, d'après W. H. Hodge. A la Guadeloupe et en Martinique, elle est associée à *Geonoma Dussiana*. Enfin, à Trinidad, ce sont les *E. Broadwayana* et *E. pubigera*.

Des *Pitcairnia* et *Guzmannia*, broméliacées terrestres, sont électives de ces palmeraies dans les diverses îles.

## Richesse Floristique, Endémisme, Affinités et Séries Végétales

*Richesse Floristique.*— Dans l'ensemble, l'archipel caraïbe n'offre qu'une richesse phanérogamique moyenne, comparable à l'une des Grandes-Antilles, comme Puerto-Rico, la plus petite de celles-ci et la plus proche de nos Iles; par contre l'abondance des genres et espèces de Cryptogames est relativement élevée. On peut estimer à plus de 4.500 les Phanérogames et à 500 environ les Ptéridophytes, soit, à peu près, 5.000 végétaux vasculaires au total.

Pour les Antilles françaises, plus spécialement étudiées par nos soins, de petites îles, comme St-Martin ou St-Barthélémy, ne renferment pas plus de 500 espèces, alors que la Guadeloupe seule possède dans sa flore spontanée, d'après

notre décompte le plus récent 2.015 plantes vasculaires réparties en 862 genres dont 298 Ptéridophytes (55 genres) et 1.717 Phanérogames (807 genres) ainsi décomptées: 2 Gymnospermes (2 genres), 454 Monocotylédones (189 genres), Dicotylédones Apétales: 163 espèces et 58 genres, Dialypétales: 636 espèces en 312 genres et Gamopétales: 462 en 246 genres. Ce nombre est élevé quand on le rapproche de la faible superficie de l'Ile, couvrant seulement 1.500 km$^2$.

Pour la Martinique, le total est de 822 genres et 1.798 espèces pour les Plantes vasculaires, dont 50 genres et 254 espèces pour les Ptéridophytes; 772 genres et 1.544 espèces pour les Phanérogames, dont 2 genres et 2 espèces pour les Gymnospermes, 173 genres et 392 espèces de Monocotylédones, 61 genres et 142 espèces d'Apétales, 304 genres et 590 espèces de Dialypétales et 232 genres et 418 espèces de Gamopétales.

L'archipel des Antilles Françaises recèle, suivant nos recherches et conceptions et, dans l'état actuel de nos connaissances, 859 genres, 1.965 espèces et 137 variétés de Phanérogames et 57 genres, 320 espèces et 20 variétés de Cryptogames vasculaires, soit un total de plantes vasculaires s'élevant à 916 genres, 2.285 espèces et 157 variétés. Ces valeurs sont proches de celles attribuées pour Puerto-Rico dans les flores les plus récentes, par IGN. URBAN (Symbolae Antillanae) ou BRITTON et WILSON (Botany of Porto-Rico) pour les Phanérogames et par WM. R. MAXON (Botany of Porto-Rico: Pteridophyta) pour les Cryptogames vasculaires, dont 285 sont décrites.

Pour la Dominique, les études de DOMIN, complétées par celles de HODGE, permettent de porter le nombre des fougères et alliées à 203 espèces seulement, mais l'Ile est insuffisamment connue botaniquement. Le rapport des Ptéridophytes au total des plantes vasculaires est de 1 pour 7,5 plantes. Cela met en lumière la richesse ptéridophytique relative, puisque FÉE estime que pour les Tropiques et l'Equateur, zônes les plus pourvues en Fougères, elles entrent environ pour le neuvième de la végétation totale.

En ce qui concerne les Mousses, notre récente étude sur la végétation muscinale des Antilles françaises, fait apparaître pour celles-ci un total de 2.900 espèces de plantes feuillues, dont 410 muscinées; 200 Hépatiques et 210 Mousses (*str. sens.*), soit une proportion de 1 mousse pour 7 végétaux à feuilles. Les champignons du groupe Martinique-Guadeloupe, d'après les récoltes de DUSS et nos observations s'élèvent à 600 espèces, y compris les champignons microscopiques.

Les familles botaniques dans lesquelles se rangent les genres et espèces des végétaux vasculaires spontanés les plus abondamment représentés aux Antilles françaises, sont respectivement, dans l'état actuel: Légumineuses: 66 genres et 167 espèces, Graminées: 59 genres et 150 espèces, Composées: 53 genres et 103 espèces, Polypodiacées: 43 genres et 226 espèces, Rubiacées: 40 genres et 80 espèces, Orchidacées: 38 genres et 119 espèces, Euphorbiacées: 35 genres et 78 espèces et Cypéracées: 18 genres et 92 espèces.

Parmi les genres, dans leur concept normal, en accord avec les règles internationales de la nomenclature et les monographies génériques ou révisions les plus récentes, ce sont les genres *Dryopteris* et *Peperomia*, qui sont les plus représentés avec 43 espèces pour chacun d'eux, puis *Polypodium:* 37, *Eugenia:* 26, *Epidendrum* et *Piper:* 24, *Solanum:* 23, *Elaphoglossum:* 22, *Trichomanes* et *Panicum:* 20, *Miconia* et *Hymenophyllum:* 19, *Paspalum, Cyperus* et *Lycopodium:* 18, *Asplenium, Sida* et *Cassia:* 18 espèces.

*Endémisme.* — L'Archipel des Petites-Antilles, tant les Iles Sous-le-Vent que les Iles Caraïbes du Nord et du Sud, n'offrent pas, en raison de leur caractère de transition entre le continent Sud-Américain et les Grandes-Antilles, de leur âge récent, de leur orogénèse et des multiples phénomènes géologiques, qu'elles ont subi, un endémisme élevé, en dépit de leurs caractères insulaire et montagnard. Dans le Catalogue des Phanérogames des Antilles françaises, H. et M. STEHLÉ et le R. P. L. QUENTIN (1937), estiment à 165 le total d'endémiques des végétaux à fleurs sur 1.700 espèces examinées, soit un peu moins de 10%. Sur ces 165 endémiques, la Guadeloupe en recèle 86, la Martinique 58 et 21 sont communes aux deux îles. Ce sont les Pipéracées, les Orchidées, les Myrtacées, les Euphorbiacées, les Composées, les Sapotacées, qui, dans l'ordre d'importance, en recèlent le plus. Ils estiment à 5% (86 sur 1.550) ce taux pour la Guadeloupe et 4% (58 sur 1.400) pour la Martinique.

Ces pourcentages sont très voisins de la réalité dans l'état présent de nos connaissances. L'endémisme est surtout développé en forêt hygrophytique et en sylve altitudinale.

L'Ile de Trinidad en possède sans doute un taux plus élevé, mais la flore de l'Ile n'a pas fait l'objet de publication récente complète permettant d'en énoncer la proportion.

Souvent, des espèces endémiques d'un même genre, très affines entr'elles, comme *Clusia, Geonoma, Euterpe, Myrcia, Eugenia, Tabebuia,* etc., sont distinctes avec chaque île et sont des endémiques insulaires, paraissant dériver de *phyla* ou ancêtres communs.

*Affinités Floristico-Géographiques.* — Les affinités floristiques de l'Archipel Caraïbe confirment son histoire géologique et sont en rapport avec la localisation et les conditions édaphoclimatiques. A propos des Orchidales et des Pipérales dans les Antilles françaises, il nous a été donné de discuter ces affinités avec quelques détails. Elle peuvent être résumées en une liaison floristique avec le Vénézuéla et la Guyane d'une part, avec les Grandes Antilles d'autre part, plus étroite qu'avec le Mexique ou le Panama et les autres territoires américains, bien qu'on ait géographiquement classé l'Archipel des Antilles dans l'entité "Amérique Centrale." L'Ile de Puerto-Rico est botaniquement très affine de l'Archipel des Petites-Antilles.

Entre elles, les îles volcaniques élevées et boisées, présentent plus d'affinité et des endémiques plus nombreuses que les îles basses, calcaires et peu boisées.

*Séries Végétales et Associations.* — En outre des types de végétation primitifs décrits, appartenant aux climax forestiers, l'on peut classer la végétation naturelle de l'Archipel Caraïbe en séries écologiques de la manière suivante; les associations présentant avec chaque île des endémiques insulaires parfois différentes, mais l'allure physionomique et écologique des séries demeure comparable.

(*a*) *Associations maritimes de la série halophile.* — Elles comprennent des "herbiers" sous-marins, dans l'eau salée, à *Thalassia testudinum.*

*Cymodocea manatorum,* avec les algues; ensuite la végétation des lagunes à eau saumâtre à *Ruppia maritima,* la plus halophile et à *Cyperus elegans,* parmi les plus côtiers, puis la mangrove, à laquelle succède un stade herbacé à grandes fougères aux spores dorées: *Acrostichum aureum,* enfin la pelouse semi-hydrophile de lagunes à eau douce, à *p*H voisin de 7, à *Fimbristylis ferruginea* et autres Cyperacées, et l'association transitoire à *Sesuvium portulacastrum-Batis maritima,* sur sables imprégnés d'eau saumâtre.

(*b*) *Associations littorales de la série psammophile.* — L'association des pionniers sur sables, en bordure de la Côte, est à *Ipomoea pes-caprae-Canavalia maritima* dans toutes les îles comme dans les anciennes Antilles Danoises (BOERGESEN et PAULSEN, 1898), à Puerto-Rico (GLEASON et COOK, 1929), à Hispaniola (CIFERRI, 1936) et même en Amérique du Sud et à Java où SCHIMPER l'a décrite. L'association stabilisatrice est à *Sporobolus indicus-Heliotropium ternatum* var. *Leonardii* Stehlé nov. var., comme au Diamant, St-Lucia et surtout à Ste-Anne, en Martinique. Un faciès comparable existe à la Grande-Savane de la Dominique; elle est l'homologue de l'association à *Sporobolus pungens* du littoral méditerranéen de France.

L'association de la face marginale des arènes est à *Melanthera deltoidea-Lippia nodiflora,* avec *Ernodea littoralis* en Guadeloupe, comme en Haïti.

La végétation buissonnante des côtes commence avec les taillis à *Coccoloba uvifera* dans tout l'Archipel. Aux Antilles Danoises près Puerto-Rico, c'était l'association à *Coccoloba-Hippomane,* mais aux Iles Caraïbes, l'*Hippomane mancinella* est plus généralement en peuplements presque purs et non associé à *Coccoloba uvifera.* Le vent imprime à ces sous-arbrisseaux un aspect en plan incliné caractéristique.

(*c*) *Colonisations lithophiles.* — Les falaises sont colonisées par des associations d'aspect et de composition différents suivant leur constitution: Les madrépores et récifs coralliens sont couverts par le *Strumpfia maritima-Lithophila muscoides,* en Guadeloupe et par *Lithophila-Portulaca martinicensis,* en Martinique. Les falaises calcaires ou de tuffs sont couvertes par l'association à *Suriana maritima-Pectis humifusa.* Les falaises volcaniques, à blocs labradoritiques ou andésitiques, de Guadeloupe, Martinique, Saintes, Désirade et St-Lucia, sont colonisées par *Pitcairnia ramosa, P. latifolia* et *P. angustifolia,* avec des pieds rabougris de poiriers: *Tabebuia pallida,* prenant pied sur les falaises à pic et constituant les premiers bosquets auprès de la mer. Sur les plus hauts sommets des iles les plus élevées: Dominique, Guadeloupe et Martinique, une colonisation semblable des falaises et des blocs volcaniques jusqu'aux abords des cratères s'observe, avec *Pitcairnia bracteata* et *Guzmania Plumieri.* Les dépôts meubles et les brèches de nuées ardentes en Martinique sont couvertes par le *Thunbergia grandiflora,* naturalisé (liane de Chine) avec l'*Hamelia patens* (fleur-corail).

(*d*) *Associations de la série hydrophile.* — Elles sont diverses et comprennent: les lagunes côtières d'eau stagnante acide à *Annona glabra-Dalbergia ecastophyllum,* la savane tourbeuse acide à *Dryopteris gongylodes-Heleocharis mutata,* les plaines latéritiques ou alluvionnaires inondées à *Fuirena umbellata-Mariscus jamaicensis,* de Guadeloupe et à *Fuirena-Rhynchospora,* en Martinique, homologue de celle à *Typha-Mariscus,* de Puerto-Rico et *Cladium-Mariscus,* d'Haïti.

La zonation des lagunes d'eau douce et des mares met en évidence plusieurs ceintures: des espèces flottantes à *Nymphaea,* des intermédiaires à *Heleocharis,* des hélophytes de vases semi-liquides et limons à *Pistia,* des électives de sédiments à *Polygonum* et des espèces marquant la zone de balancement hydrostatique à *Alternanthera, Rotala* et *Aeschynomene.* Les canaux et fossés à eau stagnante sont à électifs de *Cuphea, Jussieua, Eclipta* et *Cyperus,* les rivières à cours lent d'*Heleocharis, Digitaria, Tradescantia* et *Calathea,* alors que les sources ont des Scrophulariacées dominantes: *Bramia Monieri, Lindernia microcalyx, L. diffusa,* et *L. crustacea* et les ravines et cours d'eau rapides en forêt possèdent sur leurs pierres: *Potamogeton fluitans,* des *Tradescantia* et des mousses. Les sources sulfureuses sont caractérisées par les 2 fougères *Histiopteris incisa* et *Dryopteris reticulata.* Les marécages des plus hautes altitudes constitués entre les couloirs rocheux sont colonisés par l'*Heleocharetum maculosae* de la Montagne Pelée (Martinique), de la Soufrière (Guadeloupe), du Morne Watt (Dominique), avec *Heleocharis maculosa, H. retroflexa* et *Isachne rigidifolia.* La formation culminale, dans les plus hautes îles, est un *Sphagnetum* hydrophile avec *Sphagnum portoricense* et *Sph. meridense,* diverses autres muscinées *str. sens.* et quelques phanérogames rares et caractéristiques de cette strate musciphile: *Gaultheria sphagnicola, Peperomia tenella* et *Relbunium guadalupense,* avec des *Selaginella* et *Lycopodium.* Cette formation de tourbières d'altitude existe en Guadeloupe et Dominique mais non en Martinique ni à Trinidad.

### ÉVOLUTION RÉGRESSIVE DE LA VÉGÉTATION CARAÏBE

L'équilibre biologique des "climax forestiers" rompu, une évolution régressive s'observe sous l'action de l'homme ou des cataclysmes violents, tels que les cyclones fréquents et les éruptions volcaniques. Parmi les plus récents on peut citer ceux du Lac Bouillant de la Grande-Soufrière du Morne Watt à la Dominique, éruption de Janvier 1880 et tremblement de terre de 1906, éruptions de la Soufrière de St-Vincent en 1896, de la Montagne Pelée en Mai 1902 et en 1929 à la Martinique, le cyclone du 12 Septembre 1928 en Guadeloupe. Parmi les plus épouvantables cataclysmes, sont à citer: le tremblement de terre du 11 Janvier 1839 de la Martinique, St-Lucia, Guadeloupe et Dominique et ceux de 1843 et 1844. Du 8 Janvier au ler Juin 1843, la Martinique n'a pas ressenti moins de 200 secousses de tremblement de terre. Le 8 Février de la même année, la plus grande ville de la Guadeloupe, Pointe-à-Pitre, fut détruite entièrement au cours d'une secousse qui dura 105 secondes, ainsi que l'a exposé le remarquable géologue de l'époque, CH. STE-CLAIRE DEVILLE, et toutes les plantations furent détruites dans l'Ile. Il y eut 2000 morts et 1500 blessés et elle fut ressentie dans toutes les Petites Antilles, surtout à Marie-Galante, Antigua et jusqu'en Guyane. Du 8 Février 1843 au 16 Avril 1844, 324 secousses furent comptées à la Guadeloupe; celle du 12 Janvier 1844 fut également ressentie à la Martinique.

De gros arbres des forêts intérieures de la Guadeloupe, abattus par le cyclone de 1928, étaient encore gisants et en voie de décomposition en 1934 à notre arrivée et on en observe

des souches pourrissantes en Forêt des Bains-Jaunes. Mais, en dépit de leur violence, parfois inouïe, les cataclysmes n'affectent pas la végétation primitive autant que l'action lente, continue et incessamment renouvelée de l'homme, pour l'exploitation forestière et la culture.

La végétation subit alors une action régressive qui débute en forêt par des trouées où l'humus est exploité par des espèces de croissance rapide, des essences de lumière et où parfois, si l'homme ne renouvelle pas ses dégâts ou si les perturbations naturelles ne sont pas réitérées, à bref intervalle, des arbres de haute progressivité de la forêt primitive prennent place pour reconstituer la formation dans sa physionomie native. Mais, si les causes néfastes sont permanentes, les successions régressives déclanchées, arborescentes, suffrutescentes et herbacées, se poursuivent et, même, des paratypes de substitution ou paraclimax, complètement différents des formations primitives, apparaissent et enfin, les disclimax, dûs à l'activité anthropo-zoogène, depuis l'époque caraïbe jusqu'à la période actuelle, couvrent le terrain de leur végétation pantropicale, tendant vers l'ubiquité.

*Evolution Régressive de la Mangrove.* — Sur les brindilles de mangliers et les déchets constituant les sols en formation de la mangrove, après la coupe des palétuviers, à leur lisière ou dans les clairières, la luminosité plus grande et le dessèchement progressif de l'eau, permettent l'installation d'un stade à *Acrostichum aureum,* ou fougère dorée, après laquelle la pelouse semi-hygrophile de Cypéracées et Graminées prend place, avec des *Paspalum-Digitaria* et des *Cyperus-Kyllinga* ou *Fimbristylis.* Plus rarement, les palétuviers du *Rhizophoretum,* par les *Conocarpus* et *Laguncularia,* recolonisent les espaces les plus halophiles du peuplement à *Acrostichum.*

*Evolution Régressive de la Forêt Xérophile.* — Les principales causes de régression de la forêt xérophile sont: l'exploitation des bois, les feux préculturaux et les incendies pastoraux. Les forêts littorales ont été déboisées pour la construction de cases et la confection de canots nécessaires à la population de pêcheurs installée sur les bords, depuis Curaçao jusqu'à Anguilla, car toutes les îles possèdent cette forêt et ses paratypes de substitution, singulièrement identiques. L'érosion des pentes, l'irrégularité d'écoulement des eaux, le tarissement des rivières et la diminution de la fertilité du sol, en ont résulté.

Les dérivés frutescents qu'elle présente sont: le taillis à *Chrysobalanus Icaco,* sur sables, celui à *Lantana involucrata* ou le hallier épineux à *Randia mitis-Lantana involucrata,* sur les côtes sèches et arides, sur calcaires intercalés de tuffs, le taillis à campêches introduits et naturalisés, à *Hematoxylon campechianum* et surtout les divers faciès du taillis à *Croton,* parfois d'origine édapho-climatique mais le plus souvent dû à l'action du feu, de la coupe réitérée et de l'influence du cabri à son égard; il présente alors l'embuissonnement pyrophytique particulier si bien décrit par G. KUHNHOLTZ-LORDAT dans la "Terre Incendiée" (1939). Les espèces qui le forment varient d'une île à l'autre, mais les plus abondants sont: le *Croton balsamifer,* le *C. Dussii* et le *C. Guildingii.* Le taillis à *Lantana Camara* var. *aculeata,* dû à l'action pyrophytique, prend une large extension, car il est doué d'un grand pouvoir colonisateur et rappelle des colonisations récentes analogues de l'Amérique du Sud, de la Nouvelle-Calédonie, et de l'Afrique. A Madagascar, il succède à la "savoka."

Les dérivés herbacés sont: l'association hyperxérophile à *Bouteloua americana-Sida* sp. pl., avec *Andropogon, Paspalum,* le *Themeda* asiatique et l'*Hyparrhenia* africain, tous deux naturalisés et envahissants, sur ces littoraux dégradés de certaines îles et, enfin, les associations ouvertes, sur terrains nus, à Agaves et Cactacées, dont les unes sont communes à plusieurs îles de l'Archipel comme *Agave caribaecola, Furcraea tuberosa, Cactus intortus, Opuntia Dillenii* etc. C'est à Curaçao, où SURINGAR a fait une excellente étude descriptive des Cactacées, élargie ensuite remarquablement par BRITTON et ROSE pour toutes les Antilles, que le développement des formations succulentes sur terrains arides se révèle le plus poussé.

*Evolution Régressive de la Forêt Mésophytique.* — Les dérivés de la forêt mésophytique dans l'Archipel Caraïbe sont de conséquence culturale, après destruction forestière, mais avec emploi du feu plus intermittent et plus limité que pour la forêt xérophile. On y observe des successions frutescentes et herbacées. Les dérivés frutescents comprennent toujours des taillis à *Piper,* figurant en sous-bois et gagnant rapidement les espaces libres, surtout le *P. dilatatum,* qui est de 3 à 5m. de haut et de type foliaire mésophylle. La brousse à *Solanum,* de différentes espèces suivant les îles, existe aussi bien, même avec des endémiques particulières, à Margarita (JOHNSTON), que dans les Antilles néerlandaises (BOLDINGH) et dans les Antilles françaises (STEHLÉ), où il est à *S. triste* à la Martinique et à *S. asperum* à la Guadeloupe. Le taillis à *Cordia* buissonnants tels que *C. martinicensis, C. cylindrostachya* et *C. ulmifolia* ou à *Miconia* de diverses espèces: *M. guianensis, M. prasina, M. laevigata,* etc., sur latérites ou talus à débris humifères, ont un aspect assez homogène, observé dans les îles de la Guadeloupe, la Martinique, St-Lucia et aussi bien à la Dominique qu'à Barbados ou Trinidad. Les dérivés herbacés sont les savanes hautes, à *Pharus latifolius-Olyra latifolia,* relicts du sous-bois antérieur, avec *Oplismenus* et *Ichnanthus,* une savane haute mais de substitution, d'espèces introduites et naturalisées, à *Panicum maximum-P. barbinode* et *Setaria,* une pelouse basse à *Desmodium supinum-D. axillare* et autres espèces du même genre, avec des électives variées suivant les diverses îles.

*Evolution Régressive de la Forêt Hygrophytique.* — La régression de la forêt dense et humide a lieu à la suite d'exploitations abusives pour le bois, le charbon et les cultures, sans emploi de feu courant à l'origine car la combustibilité des arbres toujours humides et dans une atmosphère presque à saturation totale est très restreinte. Les dérivés arborescents comprenant des peuplements forestiers secondaires à *Cecropia peltata* et à *Ochroma pyramidale,* associés ou isolés, avec *Hibiscus tulipiflorus,* sont les paratypes sur humus dans les îles où la dégradation a eu lieu sans retours successifs, à périodes rapprochées, entre 750 et 1.000 m. d'altitude (2.400-3.200 feet) et où de l'humus existe. Ils sont à type foliaire macrophylle. Les essences de haute progressivité, comme les *Sloanea, Chymarrhis, Sterculia* ou *Phoebe,* peuvent regagner ces peuplements à la forêt en une révolution d'environ un-demi siècle. Ils sont comparables à ceux d'Amérique du Centre ou du Sud à *Cecropia* d'espèces diverses et aux Moracées-Arthocarpées africaines, comme le "combo-combo:" *Mu-*

*sanga Smithii* de l'Ogoué et les espèces de parasoliers de croissance rapide ou celles de la "Savoka" de Madagascar.

Les fougères arborescentes à *Cyathea arborea* et *Hemitelia grandifolia,* avec d'autres espèces voisines, et les Araliacées arbustives à *Oreopanax* et *Didymopanax,* forment des peuplements importants sur laves récentes, le long des pentes volcaniques de la Montagne Pelée, en Martinique et des pentes, autrefois dénudées par les cyclones et les défrichements, au Houélmont, en Guadeloupe. Des peuplements substitués, à *Bambusa vulgaris,* asiatique et à *Jambosa vulgaris,* de l'Inde Orientale, forment de larges colonisations dans les étages de la forêt humide, hygrophytique ou mésophytique, dans toutes les Iles de l'Archipel.

Les dérivés frutescents, sur sols acides, à complexe argilo-humique faible, mais de forte teneur en hydrargile et dont le *p*H oscille de 5 à 6,5, comprennent: le taillis à *Miconia guianensis-M. trichotoma,* avec diverses espèces: *Palicourea crocea, Eugenia* sp. pl., etc. Le taillis à *Nectandra-Ocotea,* de Lauracées dominantes, remplace celui à Mélastomatacées sous microclimat moins hygrophile; il est à "crés-crés" (*Miconia*) abondants dans la plupart des îles, de la Guadeloupe à Trinidad. Le taillis à *Byrsonima spicata* se développe sous le couvert des taillis vieillissants de lauriers et crés-crés et constitue des formations analogues aux "chumiscales" à *Curatella americana* de Panama, décrites par HEMSLEY, de 1886 à 1888, à l'association à *Curatella-Byrsonima-Miconia* du Costa-Rica, décrite par TONDUZ, de 1892 à 1896 et aux "parajales" à *Byrsonima-Curatella-Miconia* de CIFERRI, 1936, pour Cuba, Haïti et St-Domingue. Pour la Guadeloupe en 1936 et la Martinique en 1937, nous en avons donné la physionomie et la composition. Depuis, nous l'avons observée à la Dominique et à St-Lucia et, dans "la végétation de montagne dans les Antilles," J. S. BEARD a indiqué la composition par ordre de fréquence de l'association la plus importante de Trinidad à *Licania ternatensis-Byrsonima spicata* (bois gris-serrette), dans laquelle figurent de nombreuses Lauracées (*Ocotea*), Myrtacées (wild guava) et Mélastomacées (*Miconia* dit sardine), qui sont, dans la forêt hygrophytique, *lato-sensu,* celles des formations primaires dégradées et secondaires correspondantes aux autres îles des Petites Antilles.

Les dérivés herbacés sont constitués par les pelouses, moyennes ou basses, à l'orée des taillis décrits méso-hygrophiles ou en marge des lambeaux forestiers et comprennent: la savane à *Clidemia hirta-Rubus rosaefolius,* avec de nombreuses électives de familles variées, la pelouse à *Sauvagesia erecta* et la prairie à *Phenax vulgaris* et *Hyptis atrorubens.*

Dans chacune des grandes îles de l'Archipel Caraïbe, l'on peut, comme cela a été fait pour la Guadeloupe (1936), distinguer dans l'étage moyen de ces îles d'abord, un noyau central de forêt primaire non dégradé, proportionnellement très élevé à la Dominique et à la Guadeloupe, assez élevé à St-Lucia, Grenada, St-Kitts, moins abondant à Trinidad et à la Martinique, dont les genres sont à peu près les mêmes et beaucoup d'espèces sont en commun; ensuite une forêt primaire dégradée, présentant, en proportions variables, suivant le degré d'exploitation abusive et d'évolution régressive, un mélange plus ou moins abondant d'essences de lumière de la forêt dense, un abondant sous-bois et une brousse d'espèces de la forêt secondaire; enfin un paratype de substitution, constituant la forêt secondaire, dans laquelle les plus hautes espèces de la forêt primaire ont été éliminées. Les essences de haute progressivité qui subsistent encore dans la forêt primaire dégradée, sont des points d'appui permettant de remonter par étapes successives les stades antérieurs, pour recréer l'atmosphère perdue de la sylve umbro-sciaphile. C'est là que se place l'action intensive de reconstitution de l'homme pour aider la Nature à se recréer dans son état primitif et réparer les dégradations et les mutilations qu'il lui a fait subir.

*Évolution Régressive de la Forêt Altitudinale.* — Les dérivés de la sylve montagnarde sont dûs aux éboulements, aux orages fréquents et violents, aux dénudements des à-pics exposés à la fois au ruissellement intense et à l'insolation, ou aussi, à un degré moindre, aux coupeurs de choux-palmistes. Les inclusions dégradées ou à croissance secondaire sont assez peu étendues, mais on les rencontre sous deux formes communes à plusieurs iles: les peuplements à *Oreopanax Dussii* ou autres Araliacées à amples feuilles et la brousse, en amas denses, à *Dicranopteris bifida, D. Bancroftii* et autres fougères, dont les frondes découpées et allongées, contribuent à donner un aspect dentelé aux aires qu'elle occupe, dans les écorchures des parois argileuses ou des pentes volcaniques des plus hauts sommets. Des Lycopodes, fougères, mousses, sphaignes et Orchidées, terrestres et épiphytes, parent les arbres de ces faciès de dégradation d'un chevelu abondant tendant à donner au paysage le même aspect que la forêt d'où il dérive.

### RESSOURCES NATURELLES VÉGÉTALES, AGRICOLES ET FORESTIÈRES

*Culture Primitive Précolombienne.* — Les peuplades autochtones, précolombiennes et caraïbes, comme les hommes européens civilisés et les groupements allochtones, qui se sont installés dans l'Archipel des Petites Antilles, ont utilisé les ressources naturelles végétales, dès le début par la cueillette et l'exploitation directe. Leur action s'est naturellement portée sur les formations littorales pouvant fournir le bois pour la construction des "carbets" ou "ajoupas" leur permettant de s'abriter, pour leurs canots ou "gommiers caraïbes" pour la pêche et, plus tard, pour l'emplacement des cultures: le "yautia" ou chou-caraïbe (*Xanthosoma*), le "Kiere" ou manioc (*Manihot*), la "patate" (*Ipomoea*) et le "roucou" (*Bixa*) que les Caraïbes importèrent des bords de l'Orellane. Le "génipalea ou génipa" (*Genipa americana*) servait aux guerriers caraïbes à se teindre le corps pour le départ en guerre.

*Cultures des Premiers Défricheurs Européens et Introductions.* — Il y a plus de trois siècles, lors de la venue des premiers colons, Espagnols, Français, Anglais, Hollandais et Portugais, les diverses îles furent exploitées, défrichées et cultivées intensivement et le complexe, tant organique qu'inorganique, qui était virtuellement en équilibre fut modifié complètement. Le feu, répété ou non, la culture, le pâturage, l'élimination de nombreuses plantes indigènes, par défrichement, drainage et terrassements, ont apporté de grandes modifications à la végétation primitive et en moins de quatre siècles, l'immixion de la population blanche et noire, a transformé singulièrement le couvert végétal des îles caraïbes.

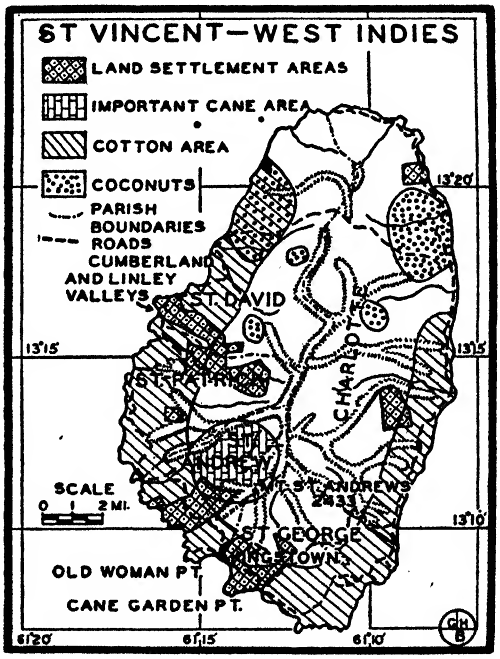
Les colons normands arrivèrent dans l'île avec les défricheurs de P. GOURNAY embarqués au

Hâvre en 1624 et accentuèrent la dégradation forestière pour la culture de la plante à pétun ou plante à JEAN NICOT (*Nicotiana tabacum*). Le tabac, le coton, l'indigo pour l'extraction de la matière colorante et le gingembre comme épice, furent les premières cultures réalisées. Dans les anciennes cultures de coton abandonnées, à Marie-Galante et en Martinique en particulier, l'*Indigofera tinctoria* et *I. suffruticosa*, constituent des postculturales et des indicatrices précieuses. Ces cultures demeuraient cependant limitées autour des Iles sur le littoral et pénétraient peu à l'intérieur ; elles occupaient des secteurs fertiles comme les terrains situés Sous-le-Vent à la Martinique, vers Basse-Terre et le Baillif et le Sud de la Guadeloupe où s'installèrent ensuite les distilleries et sucreries du "Père Labat". Aujourd'hui ce sont ces secteurs qui, en raison du caractère primitif de la culture avec le feu, avec une reconstitution insuffisante de la fertilité exploitée par de la fumure organique compensatrice ou des engrais minéraux, sont les moins fertiles et les plus exposés à la sécheresse.

La culture de la canne-à-sucre, qui devint jusqu'à ce jour, tant à Barbados qu'en Grande-Terre de la Guadeloupe et à la Martinique, une monoculture quasi exclusive, sur de larges surfaces et dans toutes les terres calcaires et plates, ne commença à prendre quelque extension dans l'Archipel qu'à partir de 1670 et contribua notablement à la dégradation de l'étage inférieur. Le cocotier (*Cocos nucifera*) d'origine colombienne ou polynésienne ne fut introduit à Puerto-Rico qu'en 1525 des Iles du Cap Vert et de là aux Petites Antilles en 1660 par le Père DIÉGO ; ses plantations constituent le long des plages et à l'intérieur des Iles de l'Archipel, même les plus petites, un des paysages les plus familiers des Petites Antilles. Les premiers manguiers des Antilles (*Mangifera indica*) dont les variétés greffées sont si nombreuses et les meilleures bien connues : Julie, Divine, Reine-Amélie, Haure, Sabot D'or, Evêché, Sans-Pareille, etc., furent introduits dans l'Archipel par les Portugais au 18ème siècle du Brésil, d'où ils passèrent à Barbados en 1750 et de là en Martinique. L'ananas vint également du Brésil d'où il est natif, importé par les Caraïbes eux-mêmes, en 1640. Le Capitaine Anglais BLIGH introduisit l'arbre à pain (*Artocarpus communis*) d'Océanie et de Tahiti aux Petites-Antilles, en 1793, où il est une des plus abondantes cultures et un des éléments les plus importants de la nourriture créole. Les divers citrus, qui firent la fortune de la Dominique, cultivés pour la consommation des fruits et la fabrication des citrates et qui demeurent dans cette île la culture principale, furent introduits d'Asie en Europe par les Arabes au 13ème siècle et de là aux Antilles par les Espagnols, au début de la colonisation. L'avocatier (*Persea americana*) vint aux Petites-Antilles du Mexique ou du Pérou, à la fin du 18ème siècle et les papayers (*Carica Papaya*) venus de l'Inde, puis du Mexique, arrivèrent en Martinique, en 1657. Si l'envers (*Maranta arundinacea*) dit de Barbade ou de St-Vincent et qui est encore la culture principale de cette dernière île volcanique, est, comme la vanille (*Vanilla*), la pomme de terre (*Solanum*) et le tabac (*Nicotiana*), une culture que l'Amérique tropicale a livré aux Petites-Antilles, le gingembre (*Zingiber*) qui fut une des premières cultures réalisées, les ignames (*Dioscorea*) et les pois d'Angole (*Cajanus*), si importants dans la nourriture des paysans antillais, nous sont venus de l'Inde.

*Agriculture Intensive Moderne et Spécialisation.* — Les cultures prirent place peu à peu, après les tatonnements du début et l'acquisition de quelque expérience agricole dans les divers secteurs, en accord avec leurs exigences édapho-climatiques. Le coton (*Gossypium*) et l'indigo se cantonnèrent sur les sables littoraux ; la canne-à-sucre sur les terres sédimentaires, calcaires ou latéritiques, les défrichements forestiers ne lui convenant guère et provoquant l'affolement des plants, l'arboriculture fruitière à *Citrus* divers, à caféiers (*Coffea*), à cacaoyers (*Theobroma*) ; avec les vanilliers (*Vanilla*), demandant plus d'humidité, pénétrèrent dans les formations mésophytiques ou en forêt hygrophytique.

La substitution d'une culture à une autre a en général pour cause une adaptation à des conditions économiques plus avantageuses, tantôt




(D'après *Econ. Geography*).

durables, tantôt passagères, mais elle peut être dûe à des cataclysmes naturels. Ainsi, à la Martinique, il y eut le 7 Novembre 1727 un violent tremblement de terre qui, au cours de trois jours consécutifs, secoua l'Ile sans pertes humaines, mais dégrada ou renversa la plupart des bâtiments en pierre et détruisit en majeure partie les plantations de cacaoyers alors fort prospères. Celles-ci furent, pour la plupart, abandonnées et on fit des plantations caféières au lieu de renouveler la culture cacaoyère. Depuis, le caféier remplaça le cacaoyer comme culture principale. Ce n'est qu'à la suite de l'attaque des caféiers par la maladie vermiculaire des racines (*Anguillula*) que ces plantations, qui occupaient encore de larges superficies à la fin du 19ème siècle, furent abandonnées à leur tour. En Guadeloupe, le cyclone de 1928 détruisit, entre autres, la presque totalité des cocotiers de l'Ile.

La régression des cultures fruitières et des plantes à boisson depuis le début du vingtième siècle laissa de nombreuses friches en ceinture de la forêt dense et le bananier (*Musa*), dont la culture reçut une large extension à Trinidad et, vers 1928 seulement, en Guadeloupe et en Martinique, prit place dans une aire semblable. Les cultures mixtes du jardin créole établies sur les "habituées" et les "concessions," dès le début de la colonisation ont régressé devant les grandes cultures à caféiers-cacaoyers autrefois, à caféiers-bananiers ensuite et enfin à cultures bananières pures ou à cultures vivrières: manioc, choux-caraïbes, madères, couches-couches et ignames (*Manihot, Xanthosoma, Colocasia* et *Dioscorea*).

Une spécialisation de l'Ile à une culture déterminée peut être mise en évidence: à Barbados, la culture principale est la canne-à-sucre, à St-Vincent c'est l'envers ou dictame, à la Dominique c'est le citronnier, à la Désirade c'est le cotonnier, en Grande-Terre de la Guadeloupe et à Marie-Galante, c'est la canne-à-sucre, ainsi que dans le Sud de la Martinique, alors qu'en Guadeloupe *str. sens.*, dans le Nord de la Martinique et à Trinidad, la polyculture mixte ou les cultures vivrières et fruitières prédominent. Les plantations d'ananas sont localisées, à la Martinique, sur les terrains latéritoïdes lourds, acides et ferrugineux du Gros-Morne, Ste-Marie et Trinité.

L'exploitation forestière est un complément de ressources plutôt qu'une richesse fondamentale pour les diverses îles dont certaines importent des bois de la Guyane voisine.

*Substitution de la Culture Pantropicale à la Végétation Caraïbe.*—La mangrove a permis après coupe et évolution régressive ou assèchement facilité par les *Eucalyptus* transitoires l'installation des petites cultures maraichères, puis de cannes-à-sucre, elle a servi à l'exploitation du bois pour les usines et les distilleries, à l'extraction du tannin dont les palétuviers contiennent dans leur écorce jusqu'à 22% de la matière sèche. Les cultures de cotonniers, de cocotiers, du tabac, du manioc, d'arbres fruitiers divers et de la canne-à-sucre ont occupé les espaces pris sur la forêt xérophytique. C'est ensuite la forêt mésophytique, qui a fait l'objet de destruction pour la culture, en particulier pour les cultures vivrières et fruitières: choux-caraïbes, caféier, cacaoyer, vanillier, rocouyer et bananier, qui ont également pénétré en maints endroits dans les secteurs secondaires et primaires dégradés de la forêt hygrophytique. Au centre des Iles, la topographie favorable permettant la protection naturelle de la forêt par des difficultés d'accès, d'exploitation et d'évacuation des produits, alliée à des conditions climatiques exagérément humides, ont permis la conservation du noyau central de forêt hygro-sciaphile dans son état primitif.

*Aperçu sur les Principales Ressources Forestières de l'Archipel Caraïbe et Réforestation.*—Les principales essences forestières de l'archipel des Petites-Antilles peuvent être classées d'après leur utilisation en: bois d'ébénisterie fine, comme *Swietenia macrophylla* et *S. Mahagoni*, mahoganys du Honduras et des Antilles, *Calophyllum antillanum* et *C. lucidum*, galbas, *Cedrela mexicana*, acajou rouge, *Hymenaea Courbaril*, courbaril ou locust et *Hippomane mancinella;* en bois de marquetterie comme *Talauma Plumieri*, magnolia et *Aniba bracteata*, bois jaune; en bois d'ébénisterie courante ou menuiserie ordinaire et de moulure comme *Simaruba amara*, acajou blanc, *Chymarrhis cymosa*, résolu ou bois rivière, *Andira jamaicensis*, angelin, *Tapura antillana* et *T. guianensis*, bois côtes, *Cassipourea elliptica* et *C. latifolia*, bois de l'ail, *Guarea ramiflora*, *G. Perrottetiana* et *G. glabra*, bois pistolet ou carimbo; en bois de grosse menuiserie: *Manilkara Riedleana* et *M. bidentata*, balatas, *Sloanea Dussii*, *S. Massoni*, châtaigners, *S. trichostica*, bois noir et *S. trinitensis*, cabrebash; en bois de charpente: *Coccoloba diversifolia*, bois rouge; *Genipa americana*, genipa; *Pouteria Dussiana:* pomme pain, *P. dominicensis* et *P. Hartii* Stehlé, nov. comb. (syn.: *Lucuma Hartii* Hemsly), contrevent, *Buchenavia capitata*, olivier, *Ocotea leucoxylon*, laurier-fine; *O. Eggersii*, laurier-noir, *O. canaliculata*, laurier petites-feuilles et *O. arenaeensis*, laurier-stincker, *Fagara martinicensis*, l'épine jaune, etc.; des bois pour travaux hydrauliques tels que: *Licania ternatensis*, bois-gris, *Mayepea caribaea*, bois de fer, *Picramnia excelsa*, bois amer et *P. pentandra*, bois moudongue, *Dacryodes excelsa* bois gommier, bois d'aviation: *Crescentia Cujete*, calebassier, *Psidium gujava*, goyavier et *Tabebuia pallida*, poirier, roble; des bois de traverses de chemin de fer, tels que: *Haematoxylon campechianum*, campêche, *Acacia nudiflora*, tendre à cailloux et *Capparis jamaicensis*, bois noir, en bois de fente et de tonnellerie, tels que: *Sterculia caribaea*, mahoe ou mapoubaril; en bois de tour et de sculpture comme le magnolia, le bois jaune et les châtaigners cités; en bois de contre-plaqué comme l'épiné-jaune; en bois de chauffage et de charbon, tels que: *Inga laurina*, pois-doux, *Eugenia jambos*, pommier rose, *Croton balsamifer* et sp. pl., tibaumes, etc. enfin en bois de résines, gommes, glues, encens, caoutchouc et colles: *Acacia, Pilocarpus, Canella, Spondias, Rheedia, Amyris, Sapium, Dacryodes, Hura, Icica, Hippomane, Bursera, Clusia, Tovomita, Symphonia*, etc., en bois de tannins et matières colorantes: *Byrsonima, Rhizophora, Sapindus, Psidium, Avicennia, Sideroxylon*, etc.; en bois à structure spongieuse, à matières filtrantes et flotteurs, tels que: *Ochroma pyramidale*, balsa ou bois de liège, *Cecropia peltata*, bois trompette, cannon-ball ou bois canon, etc.

Enfin des expérimentations récentes d'emploi de bois pour toitures et couvertures, en remplacement de tôles d'acier, conduites à Trinidad, ont montré l'intérêt qu'il y aurait à utiliser certains bois de l'archipel à cet effet et en particulier: *Cedrela mexicana*, cedar ou acajou rouge, *Ocotea leucoxylon*, duckwood ou laurier-fine, *Hura crepitans*, sand-box ou sablier, *Hernandia sonora*, toporite ou mirobolan et *Sapium caribaeum* et S. *aucuparium*, milk wood ou bois la glue et bois de soie. On fait aussi des essences avec ces bois et le bois blanc *Simaruba amara*, à la Guadeloupe et à la Martinique. Cette pratique n'est d'ailleurs pas nouvelle et si les circonstances l'ont fait renaitre aux Antilles par nécessité au cours de ces dernières années, elle fut mise à profit par les premiers colons français et anglais, en Haïti, à la Martinique, à la Guadeloupe et enfin à la Jamaïque, île dans laquelle d'après L. V. BURNS (Roofing shingles in Jamaica, Caribb. Forester 4:9, 1942), elle remonterait au début de la colonisation antillaise, vers 1655.

Des reboisements en mahoganys du Honduras et du pays ont été entrepris dans ces deux dernières îles; des peuplements de tecks, *Tectona grandis*, ont été réalisés et expérimentés à Trinidad suivant le système "taungya" de Burma, sur plus de 2.000 âcres, depuis 1913. Des essais de reforestation en districts secs sont en cours

à St-Lucia, avec du *Cassia siamea.* Dans les bas-fonds marécageux des régions inférieures et en bordure de la mangrove, diverses espèces d'*Eucalyptus*, d'Australie et d'Algérie, ont été introduites aux Antilles françaises en 1936.

*Aperçu sur les Principales Ressources Agricoles.* — Dans l'ensemble de l'Archipel Caraïbe, on peut distinguer parmi les végétaux cultivés: les cultures importantes au premier rang desquelles la canne-à-sucre (*Saccharum*) dont les produits, sucre et rhum surtout, font l'objet d'exportation, bananiers (*Musa*), caféiers (*Coffea*), cacaoyers (*Theobroma*), cotonniers (*Gossypium*), manioc ou cassava (*Manihot*), ananas (*Ananas*), et coprah du cocotier (*Cocos*) ; des cultures vivrières et secondaires: malangas et choux-caraïbes (*Xanthosoma*), madères (*Colocasia*), ignames ou yams (*Dioscorea*), pois savon et haricot (*Phaseolus*), pois bourcoussou (*Dolichos*), arbre à pain (*Artocarpus*), pois de bois ou d'Angole (*Cajanus*), topinambour (*Allouya*), dictame ou envers (*Maranta*), le vanillier (*Vanilla*), mélongène ou aubergine (*Solanum*), tomate (*Lycopersicon*), qui entrent dans le jardin créole; les cultures fruitières arbustives: mombins et prunes-cafés (*Spondias*), cocotiers (*Cocos*), sapotilliers (*Achras*), sapotes (*Calocarpum*), avocatier (*Persea*), pommes-cannelles, cachimans, corossoliers et chérimoyes (*Anona*), groseillers (*Hibiscus*), cerisiers-côtes (*Eugenia*), barbadines et pommes-lianes (*Passiflora*), cerisiers-pays (*Malpighia*), constituant le verger ou cultivés isolément autour des habitations; les plantes d'ornement: rosiers de Cayenne ou hibiscus (*Hibiscus*), bougainvilliers (*Bougainvillea*), flamboyants (*Poinciana*), bégonias (*Begonia*), crotons (*Croton*), foulards indiens (*Acalypha*), robes d'évêque (*Coleus*), de nombreuses Liliacées, Convolvulacées et Acanthacées, herbacées, volubiles ou buissonnantes: des plantes à épices ou aromatiques: muscadier (*Myristica*), poivrier (*Piper*), cornichons du pays (*Averrhoa*), cannellier (*Cinnamomum*), vanillier et vanillon (*Vanilla*), piments (*Capsicum*), giroflier (*Caryophyllus*), bois d'Inde ou bay-oil (*Amomis*), gingembre (*Zingiber*) ; les plantes à fibres: Agaves (*Agave*), langues à boeuf (*Furcraea*), bananier-corde ou abaca (*Musa textilis*), bacoua ou vacoua (*Pandanus utilis* et sp. pl.), mahot-piment (*Daphnopsis caribaea*), des Tiliacées et Malvacées diverses utilisées comme fibres sous les noms de mahots, etc.

Enfin, de nombreuses plantes médicinales, spontanées, introduites ou naturalisées sont à citer, telles que le chardon-béni (*Eryngium*), l'ayapana (*Eupatorium*), le sureau (*Sambucus*), le quinquina de Cayenne (*Quassia*), etc., que le Docteur H. CABRE, dans un remarquable ouvrage de Phytothérapie, homéopathique et allopathique (1939), a classées en: abortives (*Aristolochia*), alexitères (*Dorstenia*), amères ou apéritives (*Portulaca*), antidotes (*Bixa*), aromatiques (*Croton, Amyris*), béchiques ou apéritives (*Capraria*), anti-blennorrhagiques (*Sida, Plumiera*), anti-dartreuses (*Cassia*), digestives (*Sauvagesia*), diurétiques (*Phyllanthus*), anti-dysentériques (*Coccoloba*), emménagogues (*Hypoxis*), émollientes (*Cordia, Pavonia*), énivrantes (*Tabebuia, Tephrosia, Ichtyomethia*), fébrifuges (*Peperomia, Citrus*), hémostatiques (*Coccoloba, Canella*), pectorales (*Dianthera* et *Hyptis*), rafraichissantes (*Zizyphus*), anti-rhumatismales (*Boerhaavea*), anti-scorbutiques (*Agave* et *Spilanthes*), anti-spasmodiques (*Datura* et *Lantana*), stimulantes (*Eupatorium* et *Verbesina*), stomachiques (*Mammea* et *Passiflora*), taenifuges (*Areca* et *Punica*), toniques et reconstituantes (*Cola* et *Chiococca*), vénéneuses (*Clibadium* et *Spigelia*), vermifuges (*Chenopodium*) et vulnéraires (*Abrus* et *Furcraea*).

*Conclusion.* — L'Archipel des Iles Caraïbes offre, sur une aire restreinte, en une série de petits ilots, une grande richesse de groupements végétaux, de paysages et de faciès, d'arbres et de plantes, correspondants à des conditions topographiques, orogéniques, géologiques, climatiques et édaphiques les plus variées. Il constitue une synthèse, intéressante et curieuse, tant au point de vue naturel que de l'action des peuples autochtones ou civilisés, de l'Ancien et du Nouveau Continents, pour lesquels il est un carrefour et un trait de liaison.

Partout, depuis le Curaçao hollandais au Sud jusqu'à l'Anguilla britannique au Nord, en passant par la Margarita Vénézuélienne et les Antilles françaises, que sont la Guadeloupe, Ile d'émeraude, et la Martinique, dénommée le paradis verdoyant, les formations primitives ont évolué et la substitution de la culture à la végétation naturelle s'est effectuée dans des conditions les mieux adaptées à chaque île.

Des ressources abondantes, de cueillette ou d'exploitation, de l'agriculture et de la forêt, tirées des utilisations les plus diverses, existent dans ce remarquable Archipel des Petites Antilles.

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J. S. P. Beard: **A Brief Review of the Vegetation of Trinidad and Tobago:** — Trinidad (1754 sq. miles) lies within sight of the Venezuelan mainland and both geologically and floristically may be regarded as a detached portion of the South American continent, the flora being South American rather than Caribbean. Tobago (114 sq. miles) some thirty miles to the north-east, is essentially similar but includes a number of typically Caribbean species which do not extend as far as the larger island.

The flora is rich for the size of the islands, comprising approximately 2,200 species of Phanerogams. In the absence of a completed modern Flora, no very accurate statistics can be given, but the families leading in local representation, with the approximate number of species of each, are as follows: *Gramineae* 183, *Orchidaceae* 165, *Papilionatae* 101, *Cyperaceae* 98, *Melastomaceae* 92, *Rubiaceae* 90, *Compositae* 81, *Euphorbiaceae* 67, *Solanaceae* 49, *Piperaceae* 47, *Bromeliaceae* 45, *Convolvulaceae* 41, *Malvaceae* 36, *Caesalpiniaceae* 36, *Mimosaceae* 35, *Myrtaceae* 33, *Araceae* 30, *Bignoniaceae* 30, *Malpighiaceae* 30.

The proportion of endemics has been estimated at 7%. About 46% of the two islands remains under natural vegetation at the present day.

The plant associations in Tobago have not yet been studied in detail. It is only possible to say that the littoral types are the same as in Trinidad, and that the major inland type appears to be evergreen rain forest.

Fourteen major vegetation types can be distinguished in Trinidad. The most widespread type is Evergreen Semi-Monsoon Forest, formed by associations of *Carapa guianensis* and *Eschweilera subglandulosa*, together with *Licania biglandulosa*, *Pentaclethra macroloba*, *Clathrotropis brachypetala*, *Sabal mauritiaeformis*, *Maximiliana elegans*, *Aniba panurensis*, *Sterculia caribaea*, *Pachira insignis*, *Terminalia obovata*, *Buchenavia capitata*, *Andira inermis*, *Diospyros ierensis*, *Chrysophyllum sericeum*, *Brownea latifolia*, *Rudgea freemani*, *Swartzia pinnata*, *Warscewiczia coccinea* and *Guarea glabra*. This formation covers the greater part of the lowlands of the centre and south, undulating land at elevations of only 100-300 feet above sea level, rarely more. It is 85% evergreen and three storied. In places these forests have been invaded by *Mora excelsa*, an aggressive, gregarious species which forms almost pure stands. *Mora* forest is taller and more luxuriant than the original type. Large stretches of it exist today in the north-east and south-east. The range of mountains which runs across the north of the island carries several distinct vegetation types, differentiated by altitude and increased precipitation. The lowland forests run up to 800 feet above which appears Lower Montane Evergreen Rain Forest with *Licania ternatensis*, *Sterculia caribaea*, *Byrsonima spicata*, *Chimarrhis cymosa*, *Tovomita eggersii*, *Marila grandiflora*, *Chrysophyllum* sp., *Eschweilera* sp., *Sloanea* spp., *Lucuma hartii*, *Ormosia monosperma*, *Acrodiclidium canella*, *Aiouea schomburgkii*, *Guarea glabra*, *Calliandra guildingii*, *Cassipourea latifolia* and *Tabebuia stenocalyx*. This is a two-storied forest, 90 feet high, 100% evergreen. Above 2,500 feet the formation changes to Montane Rain Forest, evergreen, two-storied, 60 feet high, with a poor flora. The tree constituents are *Eschweilera* sp., *Ternstroemia* sp. (?). *Oreopanax capitatum* and two unknown species. The lower storey is largely composed of the tree ferns *Cyathea tenera*, *C. caribaea* and *Pteris multiserialis* with the dwarf palms *Euterpe pubigera* and *E. broadwayana*. Finally, at the summit of Aripo, 2,800-3,085 feet, appears the elfin woodland, dense straggling thicket of *Clusia intertexta*, 20 feet high, festooned with moss.

Various parts of the island where conditions are somewhat dry, due either to excessive soil drainage or lowered rainfall, bear a formation 30% deciduous, which may be named Semi-Evergreen Semi-Monsoon Forest. There are six associations whose general constituents are *Peltogyne porphyrocardia*, *Trichilia oblanceolata*, *Brosimum alicastrum*, *Protium insigne* and *P. guianensis*, *Guarea trichilioides*, *Ficus tobagensis*, *Inga hartii*, *Mouriri marshallii*, *Tabebuia serratifolia*, *Astronium obliquum*, *Hura crepitans*, *Melicocca bijuga*, *Cedrela mexicana*, *Bravaisia floribunda*, *Vitex capitata*, *Chlorophora tinctoria*, *Fagara* spp., *Coccoloba* spp. and *Trichilia trinitensis*. *Myrtaceae* form the bulk of the shrub layer, and in three of the associations the palm *Sabal mauritiaeformis* forms a large part of the lower storey. On the north-west peninsula and the islands lying off it conditions are still drier being in the lee of the Northern Range. Here the forest is a low type over 50% deciduous containing *Lonchocarpus punctatus*, *Machaerium robiniifolium*, *Tabebuia serratifolia*, *Apeiba tibourbou*, *Copaifera officinalis*, *Pisonia cuspidata*, *Bursera simaruba*, *Citharexylum spinosum* and *Clusia rosea*. Along the shore is a society with *Pithecolobium unguiscati*, *Capparis* spp., *Hippomane mancinella* and cacti, chiefly *Cereus hexagonus*.

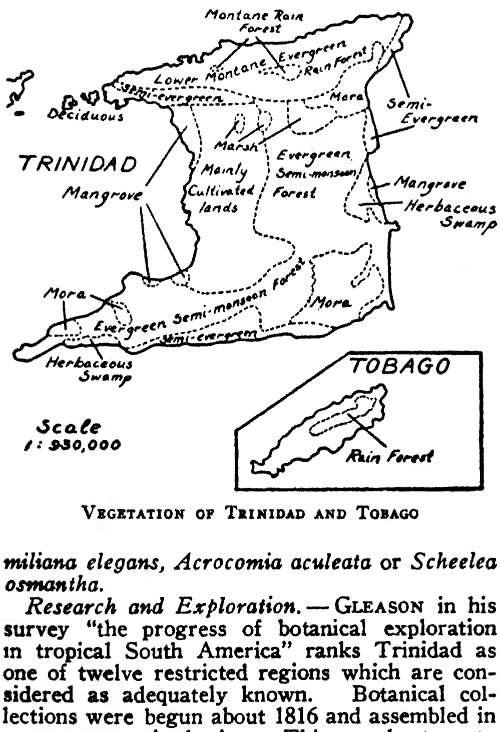
Mangrove swamps of the usual type occur round the coast, the composition being *Rhizophora mangle*, *Avicennia nitida*, *Laguncularia racemosa* and *Conocarpus erecta*. Freshwater swamp forests of *Pterocarpus officinalis* may occur behind the mangroves, or palm swamps with *Roystonea oleracea*, or herbaceous swamps of *Acrostichum aureum*, *Cyperus giganteus*, *Cyperaceae* spp., *Gynerium sagittatum* or *Montrichardia arborescens*.

Marsh vegetation (where the soil is water-logged in the rains, dry in the dry season and not permanently under water) is found on areas with underlying pan or impermeable subsoil, principally on alluvial terraces at the foot of the Northern Range. There are three types. Marsh grassland of the Aripo savanna type is short-grassland with many sedges and a number of interesting endemic terrestrial orchids, bladderworts and sundews. The fringing woodland features *Mauritia setigera*, *Chrysobalanus icaco* and *Clusia* spp. Marsh savanna-woodland is a grassland with scattered gnarled shrubs of *Curatella americana* and *Byrsonima crassifolia*. Marsh palm-forest is closed forest 70′ high with an understorey of palms — *Jessenia oligo-*

*carpa, Manicaria saccifera, Maxmiliana elegans* and *Euterpe oleracea.* The trees are *Calophyllum lucidum, Symphonia globulifera, Parinari campestris, Myristica surinamensis, Podocarpus coriaceus, Carapa guianensis, Ilex arimensis, Clusia* and *Ficus* spp., etc.

Littoral vegetation fringes the windward coast. At high water mark begins a thicket of *Coccoloba uvifera, Terminalia catappa,* T. *nyssaefolia, Pariti tiliaceum, Thespesia populnea, Conocarpus erecta, Clusia rosea, Citharexylum spinosum* and occasionally *Chrysobalanus icaco* and *Cocos nucifera.* Further back one may find pure woodland of *Manilkara bidentata* or *Roystonea oleracea.*

Secondary vegetation commonly contains large numbers of *Cecropia peltata, Ochroma pyramidale, Vismia* spp., *Croton gossypifolius, Guazuma ulmifolia, Cordia* spp., *Acnistus arborescens, Alchornea glandulosa* and *Melastomaceae* spp. Palms increase very greatly in second growth, particularly where there are fires. Frequent burning may produce almost pure stands of *Maximiliana elegans, Acrocomia aculeata* or *Scheelea osmantha.*




Vegetation of Trinidad and Tobago

*Research and Exploration.* — Gleason in his survey "the progress of botanical exploration in tropical South America" ranks Trinidad as one of twelve restricted regions which are considered as adequately known. Botanical collections were begun about 1816 and assembled in a government herbarium. This was kept up to date and enlarged for many years. In 1921 Dr. N. L. Britton, after a visit to Trinidad, produced a "Check list of the Spermatophyta of Trinidad." Based on this the preparation of a Flora was begun and the first part published by Mr. R. O. Williams in 1928. Since that time other parts have appeared by the same author and Professor E. E. Cheesman, so that about a third of the total flora has now been published. In addition there are several special papers, *see below.* In 1928 ecological surveys were begun by forest officers. A provisional outline of the plant communities was published by R. C. Marshall in 1934, and a more detailed work is now in preparation.

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V. A. Tiedjens: **Agriculture on the Islands of Curaçao, Aruba and Bonaire:** — The Netherlands West Indies islands of Curaçao, Aruba and Bonaire are located within 100 miles of the Venezuelan coast in the Caribbean. They are in the path of the trade winds and although the climate is tropical, the distribution of rainfall is such that natural vegetation consists primarily of desert types. The average rainfall on the islands is 17 inches, varying from 10 to 34 inches per year. This rainfall would support a wide variety of vegetation if it were distributed over the entire 12 months but since it all occurs during the months of September, October, November and December, it is possible only to grow economic crops during these months. Even then there is no assurance of growing high water-requiring crops since much of the rainfall is torrential in nature and quickly trickles through the porous coral rock and soil.

The topography of the islands is rolling with some high rocky points. Soil has accumulated in the valleys and one finds more natural vegetation there than on the islands in general. On Curaçao there is more natural vegetation, probably due to the fact that the coral rock formations superimposed on a diabase substrate retain more of the moisture.

Mangrove grows freely in the lagoons on the lee side of the islands. The valleys and lower lying areas where water tends to collect during the rainy season, support a dense shrub-like growth, and coconuts and fig palms are able to produce a fair crop of fruit. The vegetation on the higher ground which is a mixture of soil and coral rock is only a desert type of vegetation. The columnar type of cactus (probably *Myrtillocactus geometrizans,* but resembling in some cases *Carnegiea gigantea*) grows freely whenever a little soil accumulates. It is used for making living cactus fences. The clubs are cut and are later set in rows on the boundaries of small lots where they take root and make a very effective barrier for the flocks of goats which roam freely over the countryside. The tamarind tree (*Tamarindus indica*) grows generally over the islands, in some cases shrub-like and more or less prostrate, in others more or less erect but one-sided because of the strong northeast winds. The small shrub-like plants serve as food for goats.

Aloes (*Agave vera*) grows freely over parts of Aruba and some on Curaçao. This is the source of Aloe resin, a dark brown, bitter syrup which is exported for use in laxatives. This gives a livelihood to many of the natives who cut off the leaves, set them upright in troughs,

and collect the juice which drains out in the hot sun.

Sea grapes (*Coccoloba uvifera*) grow abundantly on the windward sides of the islands and serve as ideal material for windbreaks.

Sisal was introduced into Curaçao as an economic crop but weather and economic conditions were not suitable for the best development of the crop. Volunteer plants are now found growing in sections of the island in spots where soil and moisture favor the growth of large specimen plants. There are a number of species of prostrate-growing scant foliage plants which seem to find sufficient water to make a thin carpet.

Maize or Kafir corn as some call it, is grown by the natives during the rainy season as a source of grain for poultry. There are several poultry farms on the islands.

On the leeward side of the islands, some vegetables are being grown under irrigation and on Curaçao this is a fairly successful venture but on a very small scale.

Where potable water can be pumped from wells many tropical plants are grown in gardens. In one garden, I made a note of specimens of orange, lemon, lime, fig, date, banana, grapefruit, sapodilla, sour sop, cherimoya, papaya, and mango.

Water is a controlling item in the culture of food crops. Water from drilled wells is not always potable, some of it containing large quantities of salts which makes it unsuitable for drinking as well as for irrigation. Geologically the islands are young and the rocks contain large quantities of salts from sea water. Following heavy rains many of the wells produce fine water but as the dry season advances the salts tend to increase particularly if the wells are pumped out too frequently. It is the experience of many that soil brought in from the valleys produces fine vegetables for the first crop but produces practically no second crop. The fault has been laid to the salt in the water.

Since food must be imported to the islands, considerable thought has been given to find means of growing more of the perishable varieties on the islands. Attempts are being made by the government to build up more potential water reserves by impounding rainfall in valleys with appropriate dams and dikes. This has possibilities, but because of the porous nature of the soil, it may be several years before it would begin to be effective in increasing the water supply of the numerous wells.

To grow vegetable crops in soil with irrigation requires a special type of mentality among the native population who think in terms of big wages from the oil refineries in comparison with lower wages from agricultural pursuits. Thus there is no incentive to grow food except as a backyard garden enterprise for home consumption. Thus not only is it necessary to make it possible to grow the vegetables, but an educational program must be started which at the best is a long time project.

In order to put vegetable culture on a basis that will appeal to the investigative type of mind, the field of Soilless Culture has been given serious consideration and at the present time, plans are under way for several installations for demonstrational purposes. The Department of Landbouw, veeteelt, en Visscherij of the Government of Curaçao under the able direction of R. J. BEAUJON, established a demonstrational unit in October, 1943 at Willemstad and was very successful in growing some ten different varieties of perishable vegetables including a fine crop of tomatoes.

The Shell Oil and Refining Co. on Curaçao has plans for an extensive study of possibilities of Soilless Culture as has also the Lago Oil and Transport Co., Ltd., on Aruba.

If there is one place in this world where Soilless Culture has a future, it is on these islands of the Netherlands West Indies. Its possibilities from the standpoint of water conservation and the possibility of using the well water from the islands, and the benefits to the health of the people by furnishing them a green vegetable which can be eaten raw as well as furnishing a greater variety of vitamin-rich foods, would seem to be of inestimable value to all concerned. From the standpoint of growing conditions, there are several factors that must be kept in mind. The uniform length of day of approximately 12 hours requires that certain varieties be grown which will develop under those conditions. Not all varieties are suitable. The constant temperature of 85° F. also will have an effect on the selection of varieties. The intense bright sunshine and continuously clear weather are conducive to rapid plant growth. Windbreaks are necessary in exposed locations.

There are a few insects which give some trouble, chiefly the red spider mite which thrives under existing climatic conditions. These mites do much damage on egg plant, beans, and cucumbers and measures must be taken to keep them off the foliage.

One species of the small friendly lizards which eat foliage will also give some trouble and must be guarded against. However, it would seem that once the structures are built for the plant-growing establishments, it should be a simple matter to grow quantities of perishable vegetables which at the present time are not readily available to the people residing on the islands.

The islands of the Netherlands West Indies are ideal for the vacationist, once the tourist is permitted to travel from island to island. On Aruba, there is an American colony of delightful people which has its counterpart of Dutch people on Curaçao. Bathing and fishing facilities, and absence of flies and mosquitoes make these islands a veritable vacationist's paradise. At the present time, there are more adequate facilities for tourists on Curaçao than on Aruba.

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H. PITTIER AND LL. WILLIAMS: **A Review of the Flora of Venezuela:** — Venezuela occupies the northernmost part of South America, bounded on the north by the Caribbean Sea, to the west by Colombia, to the east by British Guiana, while southward it extends beyond the first degree of northern latitude, where it adjoins Brazil.

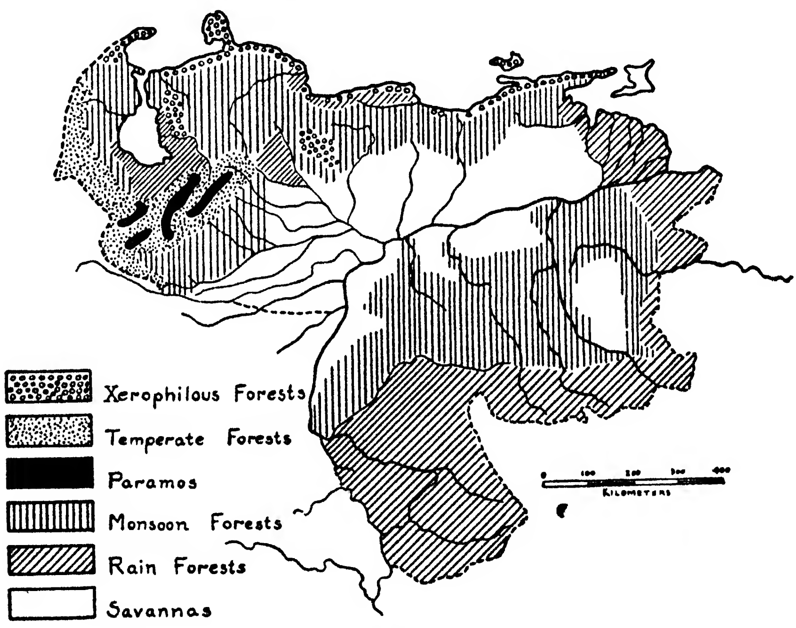
Notwithstanding the many expeditions and large plant collections made within the country up to that time, the Venezuelan species catalogued in 1917 numbered only about 1,500, and it is only during the last 24 years that a systematic botanical exploration has been undertaken and consistently pursued. Today, the National Herbarium consists of approximately 25,000 sheets, corresponding to about 12,000 species, excluding introduced plants. In the

more conspicuous families the number of species recorded up to date is as follows: *Polypodiaceae* 620, *Gramineae* 450, *Cyperaceae* 224, *Palmae* 159, *Bromeliaceae* 101, *Orchidaceae* 801, *Piperaceae* 184, *Leguminosae* 525, *Malpighiaceae* 113, *Euphorbiaceae* 204, *Melastomaceae* 231, *Solanaceae* 157, *Bignoniaceae* 103, *Rubiaceae* 357, and *Compositae* 381.

*Climate.* — In altitude Venezuela begins at sea level and reaches up to 5,000 m. Taking 27° C. as the mean annual temperature of the coastal region and 0.55 as gradient, on the basis of a long series of meteorological observations, the mean annual temperature of the highest peak of the Sierra Nevada de Mérida would be approximately -0.27° C. Between these two extremes we have all the possible variations, due not only to the elevation but also to topographical conditions. The north-northeast monsoon is the prevailing wind, blowing almost constantly with changing intensity, but it seldom attains the force of a true hurricane, and this coupled with the usual modifications due to valley and mountain breezes. The two annual seasons are determined by a period of dry weather, *verano*, from December to May, and a rainy season, *invierno*, during the remaining months. Generally speaking, the amount of rain and the number of days of precipitation vary from less than 800 mm. and 100 rainy days, along the coast and in the deforested areas of the interior, to an average of 1,800 mm. and up to 150 days of rain in the rest of the country. There is, however, great diversity between the different regions in the pluvial regime as well as in the abundance of rainfall. Thus, in the peninsula of Paraguaná or the island of Margarita years may elapse without a drop of rain, whereas in the easternmost parts of the Guayana the precipitation is almost continuous, at times exceeding 2.500 mm., with more than 200 rainy days annually.

*Origin of the Flora.* — Geologically, the eastern parts of South America, including the Andes, are still in a process of emergence and have been so since the end of the quaternary period. In the beginning the new solid surfaces were covered with luxuriant tropical vegetation, which gradually became modified as it adapted itself to the new climatic conditions, brought about by the increasing altitude of the land. Coincident with the change of the climate of the upper elevations, at first temperate later becoming colder, there was a slow but steady invasion of plants from austral regions, and even representatives of the northern flora reached the Venezuelan mountains. Antillean types also penetrated the lower belts, where we find still some relics indicating the early connection of South America with the continent of Africa. Thus, after many millions of years, the flora of Venezuela is essentially tropical in the lower altitudes, and formed mainly of austral and boreal elements in the upper reaches.

The scientific investigation of the soils has only recently been started, but we know that in composition they run all the scale between the mineralized sands and clays of the eastern mesas, and the rich humiferous earth of the virgin forests. Their chemical composition, of course, depends largely on the geological substratum or the alluvial action. Unfortunately, large areas have been subjected to intense denudation, caused by surface washing, fire, trodding by cattle, etc., consequently such districts are being slowly transformed into semi-deserts.




VEGETATION OF VENEZUELA (*Original*).

*Study of the Flora.* — The systematic study of the Venezuelan flora began with the arrival in 1754 of PETER LOEFFLING, a disciple of LINNAEUS, who undertook the exploration of Cumaná, Barcelona and lower Caroní. His investigations were terminated by his untimely death at Murucurú, in the lower Orinoco, in April. 1756. After LOEFFLING came NICOLAUS JOSEPH VON JACQUIN, AIMÉ BONPLAND, PLÉE,

VARGAS, MORITZ, WAGENER, KARSTEN, FENDLER, SPRUCE and many other eminent botanists who studied the collections made by themselves as well as by numerous other naturalists. As a result most of the country has been more or less intensively explored, the only marked exceptions being the delta of the Orinoco and the adjacent lower Cuyuní, the upper Orinoco, the Andes of Táchira and the Cordillera de los Motilones.

*Vegetative Zones.* — Topographically and floristically the country may be divided into four main natural regions, namely the Coast range, the Andes, the Llanos and the Guayana.

1) THE COAST RANGE consists of parallel ranges of variable length, extending along the littoral. It is mostly of secondary origin, flanked on both sides by somewhat continuous tertiary and quaternary deposits. The highest peaks, in the central part, are the Silla de Caracas (2,640 m.) and the Pico de Naiguatá (2,765 m.); in the eastern section the highest elevation is that of Turumiquire (2,600 m.); while in the west, the Pico de Santa Ana (850 m.) elevates itself as an isolated mass from the center of the peninsula of Paraguaná.

Approaching the coast at La Guaira, for example, we find that the vegetation in the maritime region is decidedly xerophilous. Along the open seashore grow isolated specimens of "uverillo de playa" (*Coccoloba uvifera*), and here also we find stands of cocos palms. In this arid area the *Cactaceae* are well represented by *Cereus,* notably *C. hexagonus, Nopalia cochenillifera, Opuntia Ficus indica* and *O. caribaea.* Intermixed with these succulents are thorn forests of *Peireskia Guamacho, Caesalpinia Coriaria, Prosopis juliflora, Bontia daphnioides, Jacquinia* spp., and *Capparis verrucosa.* Farther inland, approaching the foot of the slopes, flourish *Acacia tortuosa* and *A. glomerosa, Cercidium spinosum* and several species of *Pithecolobium.* The thorn forests also include several species of unarmed trees and shrubs, represented among others, by *Amyris balsamifera* and *A. simplicifolia, Esenbeckia alata, Plumeria alba, Zizyphus melastomoides, Aspidosperma Vargasii* and *A. Cuspa.*

A natural continuation of the xerophilous formation is the tropophilous or transition forest, extending up to altitudes of 700 or 800 m. This formation attains its climax in areas where there are two rather well-defined seasons. During the dry months most of the trees shed their leaves, and the bare branches produce a dry appearance suggestive of xerophilous growth. However, as soon as the rains begin there is a rapid and radical change in the general aspect of the forest, which now resembles the hygrophilous type. This formation is unusually rich in ligneous species, most of the trees being of moderate height, with straight, columnar trunks, while the fairly open undergrowth is composed of shrubs, especially of *Melastomaceae* and *Rubiaceae.*

The upper limit of the coastal range is covered, at least during the early hours of the morning, by a dense blanket of mist. On account of this high and perpetual humidity it is natural to find that the forest growth in these higher elevations is more luxuriant than that of the lower altitudes. Many of the trees attain large dimensions and one's attention is attracted to the great variety of epiphytes, ferns, many of them arborescent, and palms, mostly of small stature. Typical examples of these cloud forests are those of Colonia Tovar, ranging in altitude between 1,400 and 2,200 m., and that between Ocumare de la Costa and Maracay with a lower elevation, from 900 to 1,600 m. In this last-named area the dominant tree is "niño" or "cucharón" (*Gyranthera caribensis*). Other trees growing in association with this are species of *Tovomita, Virola, Nectandra, Pseudolmedia, Quararibea, Hirtella* and many others no less conspicuous; while the ferns are represented mostly by species of *Alsophila, Asplenium, Diplazium* and *Dryopteris.*

2) THE ANDES occupy the western and southwestern parts of the country. They present high peaks, up to 5,000 m., with intervening deep valleys, due mostly to erosion, and consist of a crystalline nucleus covered by primary and secondary deposits. The forests of the higher elevations, where a temperate climate prevails, do not attain the dimensions or the density of the cloud or rain forests of the low, tropical areas. The meso-microthermal belt, extending from 2,800 to 3,800 m., coincides with the region most suitable for the growing of potatoes and wheat, and indicates the upper limit of the high forest. In the lower elevations, below 2,800 m., flourishes the wax palm (*Ceroxylon Klopstockia*), while certain orchids, particularly the handsome *Cattleya labiata,* are conspicuous by their abundance. In the higher reaches of this belt the trees become scarcer and of smaller stature, as exemplified by *Escallonia tortuosa,* and the vegetation gradually merges into that of the *páramo.* This type attains its optimum in the lower part of the microthermal belt (alt. 3,800-5,000 m.). The vegetation of the páramo consists in the main of herbaceous plants with characteristically thick roots and coriaceous leaves, often disposed in basal rosettes. Many of these are notable for their large, brilliantly colored flowers, so that during the period of blooming the páramos present attractive panoramas reminiscent of Alpine meadows. Among the more conspicuous of these plants are species of *Hypericum* and *Geranium, Potentilla heterosepala, Aciachne pulvinata, Malvastrum acaule, Hypochaeris acaulis, Micromeria nubigena, Gentiana corymbosa, Lupinus* spp., and various species of "frailejones," *Espeletia.* The frigid climate of these high altitudes is not conducive to the growth of woody plants, at most these being represented by only a few dwarfed species of *Ericaceae* and *Hesperomeles,* usually inhabiting rocky areas exposed to sunlight.

3) THE LLANOS are not, as often depicted, an immense, open plain, comparable to the prairies of the Mississippi basin or the Argentinean pampas. On the contrary they exhibit a variable relief, as well as vegetation, and can be roughly classified into the *Llanos occidentales,* the western plains drained by the Apure river and its tributaries flowing from the Andes, and the *Llanos orientales,* the eastern plains embracing the Mesa de Guanipa, an old inland sea and river bottom dating from the quaternary period, with its own fluvial system, and the Monagas region, drained by streams having their source in the Coast range. It is true that there are vast extensions devoid of trees, elsewhere there is a combination of forest and savanna, while the banks of the numerous rivers and streams are often flanked by stretches of gallery forest. As a rule the trees constituting this mixed forma-

tion are deciduous and attain a medium stature. Typical of these are: *Copaifera officinalis, Pterocarpus vernalis, Trichilia palmetorum, Machaerium guaricense, Jugastrum Christii, Vitex orinocensis, Hecatostemon guazumaefolium* and *Licania pyrifolia.* The thorn forests are composed of *Mimosa Cabrera, Caesalpinia Coriaria, Pithecolobium tortum* and *P. guaricense, Haematoxylon Brasiletto, Randia spinosa* and *Calliandra affinis.* Of the palms, one of the most characteristic of the upper Llanos is the "palma redonda" (*Copernicia tectorum*), while the "moriche" (*Mauritia flexuosa*) forms long stands, *morichales,* in the southeastern Llanos. Other palms encountered in these plains are species of *Bactris, Attalea* and *Oenocarpus.* The intervening spaces between wooded areas are occupied by savannas, of which two main types may be distinguished, namely, *sabanas de esteros,* along the margin of bodies of water and completely submerged during the wet season, and the dry savannas, beyond the reach of periodical floods.

4) THE GUAYANA is that territory bounded on the north and west by the Orinoco river. Geologically, it is a complex of sandstone, conglomerates and products of volcano action, resting on a base of igneous rock and deeply eroded by numerous rivers. The result is a topography of mesas and mesetas, interspersed with moderately high ranges, deep valleys and canyons. Correspondingly, the vegetation is a variation from the savanna type with adjacent belts of gallery forests to the high rain forests, attaining their optimum in the lower and upper reaches of the Orinoco basin. So far only meager studies have been made of the forests of the delta of the Orinoco, but it is known that among the more conspicuous elements are: *Dimorphandra excelsa, Carapa guianensis, Calophyllum Calaba, Symphonia globulifera, Pterocarpus officinalis, Campsiandra comosa* and *Bombacopsis pachiroides,* while in open areas grow palms, especially species of *Mauritia, Euterpe* and *Maximiliana.* At higher elevations, along the wooded slopes of the Imataca range, for example, are found species of *Manilkara, Protium, Piratinera guianensis, Eperua leucantha* and *E. Schomburgkiana,* and *Cusparia trifoliata.* The middle Orinoco, as far as the rapids of Atures, is the zone of the tonkabean (*Coumarouna*), represented by several species and of which the principal, from an economic standpoint, is *C. punctata.* In this area also abound *Licaria cymbarum, Macrolobium acaciaefolium* and *M. discolor, Aspidosperma* spp., *Micrandra siphonioides, Couma* spp., and the *Lecythidaceae,* represented by species of *Eschweilera, Gustavia, Jugastrum* and *Lecythis.* The savannas of Caicara, in the middle Orinoco, are characterized by the abundance of the oil-yielding "coroba" palm (*Scheelea*).

To the southwest is the territory of Amazonas, extending between the rivers Orinoco and Guaviare and as far south as the Brazilian frontier. It includes the upper reaches of the Río Negro, also known as Guainía, and may be properly called the Casiquiare-Guainía region. With the exception of the much-traveled routes of the Casiquiare and Pimichin, the greater part of this densely forested territory still remains to be explored botanically. Of economic plants, the "chiquichique" or "piasaba" palm (*Leopoldinia Piassaba*) and species of *Hevea* are known to be abundant in certain areas, but we still lack definite data regarding the distribution of these as well as of other fiber-, oil-, or latex-yielding plants reported to exist in the region.

SERVICIO BOTÁNICO,
MINISTERIO DE AGRICULTURA Y CRÍA,
CARACAS, VENEZUELA.

G. R. GROVES: **The Plant Resources of British Guiana:** — British Guiana, the only British colony on the South American mainland has an area of about 89,480 square miles, and a population of approximately 350,000.

The colony may be divided broadly into three belts, the northern one is a low lying, flat and swampy strip of marine alluvium known as the coastal region. This rises gradually from the seaboard and extends inland for a distance varying from 10 to 40 miles. It is succeeded by a broader and slightly elevated tract of country composed of sandy and clayey soils. This belt is chiefly undulating land and is traversed in places by sand dunes rising from 50 to 180 feet above sea level. The more elevated portion lies to the south-ward of the above mentioned regions. This rises gradually to the south west between the river valleys, which are in many places swampy, and contains three principal mountain ranges, several irregularly distributed smaller ranges and in the south east parts many isolated hills and mountains. The eastern portion is almost entirely forest clad but in the south western side there is an extensive area of flat grass clad savannah elevated about 400 to 700 feet above sea level.

The country is traversed by many large rivers, which with their numerous tributaries and branch streams form a vast net work of waterways. All the largest rivers of the colony are impeded above the tide-way by numerous rapids, cataracts and falls, which render the navigation of the upper reaches difficult.

*The Coast Lands.* — The flat and comparatively narrow plain or belt which forms the coast land is to a considerable extent slightly below the level of the ordinary spring tides which flood the unprotected parts. Inland it may rise to about 10 to 12 feet above high water mark and in depth it varies from 10 miles in the west to 40 miles along the Berbice and Corentyne rivers. Its margin is protected from the sea and rivers by a dense growth of Mangrove (*Rhizophora Mangle*) and Courida (*Avicennia nitida*). Behind this growth are flat grassy savannahs mostly inundated during the rainy season.

It is along the outer most part of the coast lands from the Pomeroon to the Corentyne that almost the whole of the population and cultivation of the colony are concentrated. Situated on this comparatively narrow strip are the two towns of the colony nearly all the villages and with few exceptions all the sugar estates, roads and railways.

*Sugar.* — The sugar estates are situated on the flat plain of marine alluvium along the coast and for a short distance up the largest rivers. The area under sugar cane cultivation is appproximately 70,000 acres. The largest area under sugar cane on any one estate is 7,000 acres, the majority of the estates, however, have only from 1,000 to 2,000 acres. A large area of the front lands of the estates has been abandoned from sugar cultivation and extensions are being made further from the coast line.

*Experiments with Sugar Cane.*—The Government's experiments with sugar cane were started in 1882, when a collection of the varieties then under cultivation in various parts of the sugar cane world was commenced whilst in 1890 experiments were begun in raising canes from seed. The standard cane, the Bourbon, suffered in the nineties from fungus diseases and although the planters made every effort to prevent the spread they had to resort to cultivating introduced varieties raised from seed. The experiments with seedlings varieties have had for their object the production of new varieties of canes from which after rigorous selection and testing on experimental plots, the planters might select kinds to suit the special conditions of their plantations. This work has been considerably extended during the last 15 years.

*Rice.*—The cultivation of rice in British Guiana during recent years has made enormous strides. There is something between 70,000 and 85,000 acres under rice. Some of the abandoned front lands of the sugar estates are now used for this crop. Rice cultivation is chiefly undertaken by small farmers.

Rice appears to have been first introduced from Carolina early in the eighteenth century during the occupation by the Dutch, although another importation is recorded about 1782 during the French occupation from the French colony Louisiana. It was not, however, until 1865 that any encouragement was given to the cultivation of rice, when some sixteen acres were cultivated successfully in West Demerara. In 1886 over 200 acres were under this crop on the lower Essequibo Coast. From this date the industry gradually grew until 1898 when the area under rice was returned at 6,500 acres. Further expansion was made until the present acreage has been achieved.

Considerable work has been done by the Department of Agriculture on selection and hybridisation of varieties, with the result that the varieties now under cultivation are superior in every respect to the former kinds.

*Coconuts.*—Coconuts thrive well on the coastal lands of the colony especially where the land is more or less of a sandy nature. The coconut cultivations are scattered, being chiefly owned by small farmers, but there are a few fair sized coconut estates. Reefs of light sandy loams exist on the Corentyne Coast, along the East Coast Demerara and in the Essequibo district, where coconuts flourish and even on the heavier coastal lands they grow quite satisfactorily and bear heavy crops. The area planted with coconuts in the whole colony is approximately 26,000 acres.

*Coffee and Cacao.*—Both coffee and cacao are grown to a limited extent, chiefly in the Pomeroon and North West Districts. The robust Liberian coffee is favoured. In recent years, however, the cultivation of coffee has been on the decline. Over 4,000 acres were under coffee cultivation in 1923 but the area cultivated in 1942 was only 2,925 acres. The area under cacao is small.

*Fibres.*—In the earlier parts of the last century cotton formed an important article of export. This cotton was obtained from the varieties of the perennial tree-cotton, which are able to withstand the detrimental effects of the meteorological conditions of the coast lands. Periods of excessive rainfall frequently followed by more or less severe drought, seriously affects the yield of the introduced cotton and the quality of the product. Trials have been made with Sea Island, Egyptian and other varieties without success, while it has been demonstrated that the indigenous hardy tree cottons give comparatively small yield.

Cowra fibre is prepared from a species of the wild pineapple which is cultivated by the Aboriginal Indians for making cordage and hammock ropes. Sisal hemp was cultivated on one estate on the Mazaruni River and over 200 acres planted. Machinery was installed for the extraction of the fibre, but unfortunately had to be given up owing to a severe outbreak of the disease *Colletrichium agaves.*

In the North West District the Aboriginal Indians obtain from the unopened shoots of the Aete Palm—*Mauritia flexuosa* material known locally as "tibiseri," which is used for making hand bags and similar articles. This "tibiseri" resembles raffia.

*Rubber.*—The cultivation of Para Rubber (*Hevea brasiliensis*) has been experimented with by many of the sugar estates in different parts of the colony. Satisfactory progress was made by Para rubber on the Berbice, Demerara, Essequibo and Pomeroon Rivers and also in the North West District. Owing to the over production of rubber in other parts of the world, the cultivation of this forest crop did not prove a profitable undertaking. Many of the plantations were left untapped until the present war when rubber became an extremely valuable commodity. All the plantations are now being tapped and the yields per tree favourably compare with results obtained in other parts of the world.

*Other Forest Products.*—The forests of British Guiana cover 78,180 square miles or about 87 per cent of the total area. The forests worked for timber are in the easily accessible districts, which extend from the coast to the rapids and falls in the various rivers. Of the many species found in these tropical forests, crabwood, mora, greenheart and wallaba are the chief timbers used. The timber industry is an extremely important one since practically all the buildings in the Colony are made of wood. Timber is also exported, greenheart—*Nectandra* sp. being in greatest demand.

Other forest products include gums, oils and balata of which a limited amount is exported.

*Fruits.*—Citrus fruits including limes, grapefruit and oranges grow well in certain areas particularly in the North West District. There is the tendency to extend the cultivation of citrus fruit during recent years. Mangoes grow quite successfully on the Coastlands. Pineapples are also cultivated on the light peaty soils, while bananas can also be grown successfully. With the possible exception of limes, there is no fruit for export, in fact, there is not sufficient in most cases for home consumption.

*Ground Provisions.*—Large areas of provision crops are under cultivation. Plantain, cassava, corn, yams, sweet potatoes, tannias and eddoes are principally grown. A considerable acreage is also under leguminous crops, such as blackeye peas, cow peas and pigeon peas.

Vegetables such as tomatoes, beetroot, carrot, cabbage, lettuce and other greens can be grown with care. These, however, are mainly grown in small home gardens.

*Pastoral Industries.*—There are very large areas of coastal lands well adapted to pastoral

pursuits. Cattle raising is carried out on pasture lands in front of the sugar estates and on the coastal swamp savannahs. Through lack of proper drainage much of the pasture land in the Colony becomes swamped in the wet season, while not infrequently a drought occasions a lack of suitable water, for drinking purposes. However, cattle raising is developing and is being extensively taken up by sugar estates and large syndicates.

BOTANIC GARDENS,
DEPARTMENT OF AGRICULTURE,
GEORGETOWN, B. GUIANA.

G. STAHEL: **The Natural Resources of Surinam***: — Surinam has an area of 160,000 square kilometers.

Along the coast live Creoles, Javanese, British Indians, and aboriginal Indians (Caraibs, Arowaks, Warraus). There are about 180,000 people altogether; one-third of them live in the capital, Paramaribo. The hilly inland is unoccupied with the exception of 15,000 bush-negroes who live along four rivers and 400 Indians near the Brazilian border. The bush-negroes and the Indians are not under direct government supervision.

While the interior is covered with an uninterrupted rain-forest, in the coastal region we find savannas and extended open marshes. The alluvial coastal region consists of two parts: the continental alluvium which forms the savanna belts and consists largely of white quartz sand; and, the low fluvio-marine alluvium with fertile clay land, a part of this, however, is always submerged, and the rest is under water for the largest part of the year.

In this area lie marine deposits composed of sand, shells and old beach formations, these are frequently 1-2 m. above the low clay land and are never flooded. In early times the Indians lived on these deposits which were later occupied by the colonists. The chief city, Paramaribo, is situated on a chain of similar formations.

Neither the savanna belts nor the distant interior is fertile. The plantations, therefore, are all situated in the clay region. Every plantation forms its own "polder," which at low water can be drained through sluices or drains to the river. The first colonists began about 1650 with the cultivation of *tobacco* which was not very successful. By 1668, however, twenty-three small *sugar-plantations* were in operation. Since that time this agricultural pursuit has been maintained. At present two large sugar-plantations are still active.

After 1730 the planting of *Arabian coffee* was initiated here and reached its height between 1775 and 1800. In about 1860, this industry disappeared in consequence of the abolition of slavery. Later, however, after 1870, when Asiatic laborers became available, the industry was revived, and about 1890 the more robust *Liberian coffee*, which grows particularly well on the stiff clay soil, was introduced. This enterprise increased rapidly at the time of the decline in the cultivation of bananas in 1912. After the years 1925-1930, when prices were very high, the price of coffee slumped considerably. The coffee plantations got into great difficulties which were still increasing when, during the Second World War, the export, particularly to Norway and Sweden, became largely impossible. Several coffee-plantations, therefore, were forced to close while others tried to maintain their holdings with limited means until the return of better times.

Here in the dry regions close to the sea, *cotton-growing* was carried on from 1780 to 1860. This business was liquidated at the time slavery was abolished. Efforts made between 1920 and 1930 to revive the cultivation of this crop were wholly unsuccessful.

Although *cacao* was already planted earlier on a small scale, subsequent to 1870 its cultivation spread rapidly and reached its peak in 1895. After 1900, however, the production suddenly declined as a result of the outbreak of the Witches Broom Disease which occurs in the interior on the wild cacao. It revived somewhat when successful measures were adopted to combat the disease. However, because of the shallow character of the surface-layer of the clay soil, in the two particularly dry years 1925-26, the cacao plantations were entirely ruined, so that to-day cacao beans must be imported.

*Bananas* were cultivated here for only a short period. The variety Gros Michel was planted in 1907 and the United Fruit Company took care of the exportation of the fruit. As early as 1909, the Panama Disease became very destructive. The export quickly declined and stopped entirely in 1914. Since 1930 experiments with the immune Congo banana have been carried on under the direction of the Surinam Banana Company supported by the Netherlands Government. These extensive tests under capable leadership have procured valuable data for the possible re-establishment of this crop. Unfortunately these researches had to be discontinued temporarily because of the present circumstances.

When the Panama Disease began to destroy the banana plantations, on various holdings plantings of *Para rubber* were made. The trees developed satisfactorily. In 1915, however, the South American *Hevea* leaf disease suddenly broke out, spreading rapidly from the wild *Hevea guyanensis* to the cultivated plants. Within one or two years the young plantings were wholly ruined. As the rubber trees were satisfactorily grown in Surinam before the outbreak of this disease, rubber culture may again be tried by using the new Ford clones, which are resistant. In its native state one finds *Hevea brasiliensis* growing by preference in the temporarily inundated forest of the lower Amazon territory, and hence on terrain apparently conforming very much in character to the clay land of the plantations.

Stimulated by the moderately high prices which *rice* brought during the First World War, the small land-holders, particularly those of Asiatic origin (British Indians and Javanese) considerably extended the cultivation of rice and continued to do so after the close of the war. As the low fertile clay lands lend themselves extremely well to the growing of this crop, a further development of the product is expected, if low prices do not prevent it. Through the providing of pure seed for planting on a large scale, the quality of the export rice is improved little by little, so that competition can be better withstood.

Since 1928, on light sandy soil, the Javanese

* The author is much indebted to Dr. L. M. PERRY for kindly translating this account from Dutch into English.

settlers have planted *tobacco* in increasing quantities for local consumption. Defective curing and sorting are largely responsible for the limited sale and low prices.

The planting of *oranges* and *grapefruits* has grown in the last fifteen years with the idea of shipping these fruits to the Netherlands. Apparently, as a general rule, these fruits may be shipped in good condition in an uncooled hold to Europe, and also the shorter the time of transportation the better. These trees grow well here both in clay and in sand.

Experiments with the *coconut-palm* have given less encouraging results.

*Food-plants* have been grown in sufficient quantity for domestic consumption, and cattle-raising provides the necessary meat. There is a deficit only in oils and fats. However, efforts have been made to extract oil from the peanut and soy-bean to supplement the limited quantities of coconut-oil which are produced here.

The immense forests of the country furnish equally satisfactory *timber* for houses which here are all built of wood. Most of the trees are felled by the bush-negroes on the upper parts of the rivers, and the logs are floated down to the inhabited coastal land over a number of cataracts and rapids. Most of the lumber companies, in part well equipped, which were established here in the course of the last fifty years, have again been liquidated after a few years. So far, the export of lumber has been limited and confined to "Basra Locus" (*Dicorynia paraënsis*), a wood especially useful for harbor work because of its resistance to marine borers.

In addition to lumber, the forests also furnish *balata*. This type of rubber was shipped from here in 1895. The highest production was reached during the years 1910-1914. After that the quantity diminished, but some balata is still exported.

For a hundred years, even if somewhat irregularly, *Quassia bitter wood,* the Lignum Quassiae surinamense of the pharmacopoeia, has been exported. Very recently, however, it has been entirely supplanted by the cheaper Jamaica bitter wood.

Economically by far the most important industry of this country is the *Bauxite* trade. The American Alcoa Company operates two large mines (Moengo and Paranam), while the Netherlands Biliton Company have another one near Onoribo.

*Gold-mining* has commonly been done in very primitive ways; but, for the last ten years, a gold mining company has been working under expert leadership and using modern equipment.

The interest in agriculture has been well managed by two institutions, the Agricultural Experiment Station and the Bureau of Agric. Economics. A veterinarian, who is director of the abattoir, not only supervises its activities but also promotes interest in cattle-raising. Recently, a bureau of mines has been set up to care for the mining interests of the country.

Government Agricultural Experiment Station,
Paramaribo,
Surinam.

Alpheu Domingues: **A Agricultura no Brasil:** — O Brasil é um país reconhecidamente agricola, de extraordinarios recursos naturais do ponto de vista vegetal e mineral.

Nesses ultimos anos, a politica do governo brasileiro tem se orientado no sentido de transformar industrialmente os produtos agricolas do Brasil, para evitar que o país continuasse a ser apenas produtor de materias primas, as quais passaram a ser industrializadas dentro do proprio país.

A fitogeografía brasileira, estudada pelo grande botanico Alberto J. de Sampaio, é diversificada com uma flora heterogenea que se enquadra em oito zonas assim discriminádas: *1.* Florestas tropicais; *2.* Pinhais; *3.* Cerrados; *4.* Campinas; *5.* Caatingas; *6.* Babaçuais; *7.* Vegetação litoranea; *8.* Compléxo do pantanal.

*Florestas tropicais.* — As florestas tropicais compreendem tres formações: *1.* Floresta da região equatorial; *2.* Floresta da encosta atlantica; *3.* Floresta do vale do rio do Paraná. — *Floresta da região equatorial*: A floresta da região equatorial não se localiza apenas no Brasil. Estende-se às Guianas, Venezuela, parte da Colombia, Equador, Perú, Boliva, na parte leste dos Andes.

No Brasil ela forma a formidavel mata amazonica que é chamada tambem *Hiléia brasileira.* Aí existe a coincidencia de uma região prodigamente servida por cursos dagua, de maneira que a sua formação é de origem hidro-higrofila megatermal. A floresta amazonica é fechada e continua. Ha, porem, claros constituidos por manchas campestres, tais como os campos do Alto Rio Branco e os da margem esquerda do rio Amazonas, no Estado do Pará.

Nas florestas amazonicas se distinguem duas formações: as matas de varzea e igapó e as matas de terra firme.

Na Hiléia brasileira encontram-se entre outras arvores as seguintes: a seringueira, a castanheira, o cacaueiro, o pau rosa, a jarina ou marfim vegetal, o acapú, a massaranduba e o guaraná.

As demais florestas tropicais são representadas pelas florestas da encosta atlantica e pelas matas do vale do rio do Paraná.

Martius denominou a floresta da encosta atlantica de *Dryades.* Estende-se desde o Estado do Rio Grande do Norte até a parte setentrional do Estado do Rio Grande do Sul. Daí, na direção de oéste ela recobre a encosta meridional do grande planalto. Logares ha em que ela avança para o interior como acontece no vale do rio Doce. As grandes derrubadas de florestas que ocorreram no Nordéste, para o estabelecimento das lavouras de cana de açucar, devastaram a mata da encosta atlantica. Essa devastação tambem foi feita no sul do país principalmente no vale do rio Paraíba do Sul, para estabelecimento da cultura cafeeira. Ainda assim, entre o rio S. Francisco e a ribeira do Iguape existem logares onde essas matas se apresentam compactas e continuas. Ao norte do Rio Doce, no Estado do Espirito Santo, encontram-se agrupamentos florestais predominando o jacarandá, o assaí, a peroba, o cedro, os ipês, a imbuia, o jatobá, o jequitibá, etc.

A floresta do vale do rio Paraná compreende todas as matas que formam os vales dos afluentes do rio Paraná, pela margem esquerda, desde o Tieté até o Iguaçú e continuando pelo vale do rio Uruguay até seu afluente Ijuí. Estas matas são higrofilas.

*Pinhais.* — Estas florestas ocupam o planalto meridional do Brasil sobretudo os Estados do Paraná e Santa Catarina e irradiam-se tambem no planalto sul-rio-grandense, formadas de *Araucaria angustifolia.* Ha intercorrencias de outras

arvores como a imbuia e a hervamate. O clima nessa região é natureza sub-tropical.

*Cerrados.* — A vegetação do cerrado é o tipo que predomina no planalto dos Estados de Mato Grosso, Goiaz e parte do Estado de Minas Gerais. Encontram-se aí o pau-terra, a lixeira e a mangabeira.

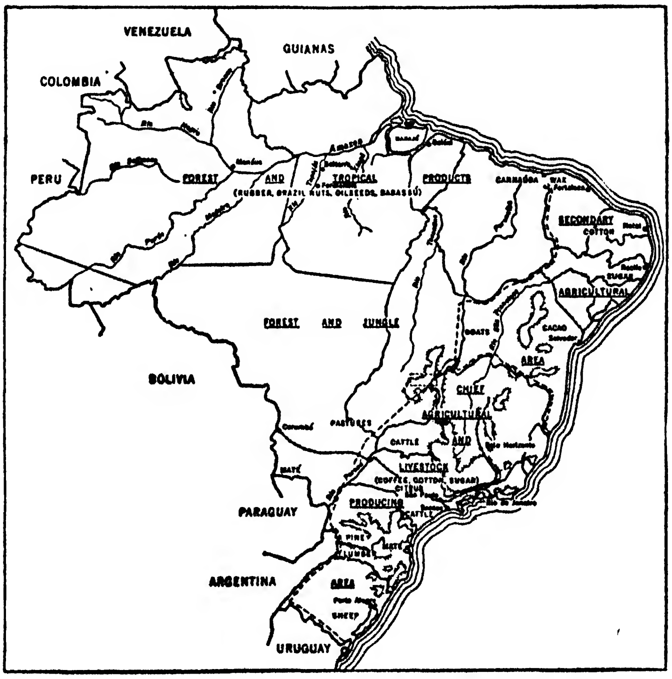
*Campinas.* — As campinas são representadas pelos campos do Estado do Rio Grande do Sul, de esplendidas pastagens naturais, na planicie que cobre a parte meridional do Estado. No altiplano tambem ocorrem os chamados campos gerais, no Estado do Paraná, Santa Catarina e Rio Grande do Sul. A mesma ocorrencia se encontra no divisor de aguas Tocantins-São Francisco e tambem no sul do Estado de Mato Grosso. Esta zona fitogeografica compreende ainda as florestas de beira de rio e os capões. As primeiras são chamadas florestas ciliares ou galerias. Os capões são verdadeiras ilhas de mata. Estas formações são de natureza hidrofila.

faixa de vegetação que fica à beira do oceano e cado entre os tres maiores produtores de milho apresenta os seguintes aspectos: *1.* Coqueirais; *2.* Vegetação das restingas; *3.* Mangues.

*Pantanal.* — Situada na baixada do Estado de Mato Grosso, entre a borda ocidental do planalto e o sulco do rio Paraguai. A vegetação é topofila. Aí o clima compreende duas estações perfeitamente distintas: o verão e o inverno. Ocorre uma vegetação composta de florestas do tipo amazonico, matas de encosta, palmeirais, cerrados, campinas, matas de beira de rio, vegetação dos alagados e vegetação aquatica. No Estado de Mato Grosso o pantanal não é brejo ou alagado permanente, como poderia parecer à primeira vista.

*CEREAIS:* — O Brasil cultiva trigo, milho, arroz, ceveda, centeio, aveia, etc.

*Trigo.* — O Governo do Brasil está empenhado, por todos os meios e formas, em desenvolver a cultura do Trigo. Em alguns Estados, como Rio




REGIÃO AGRÍCOLA DO BRASIL (Cortesia de '*Agriculture in the Americas*').

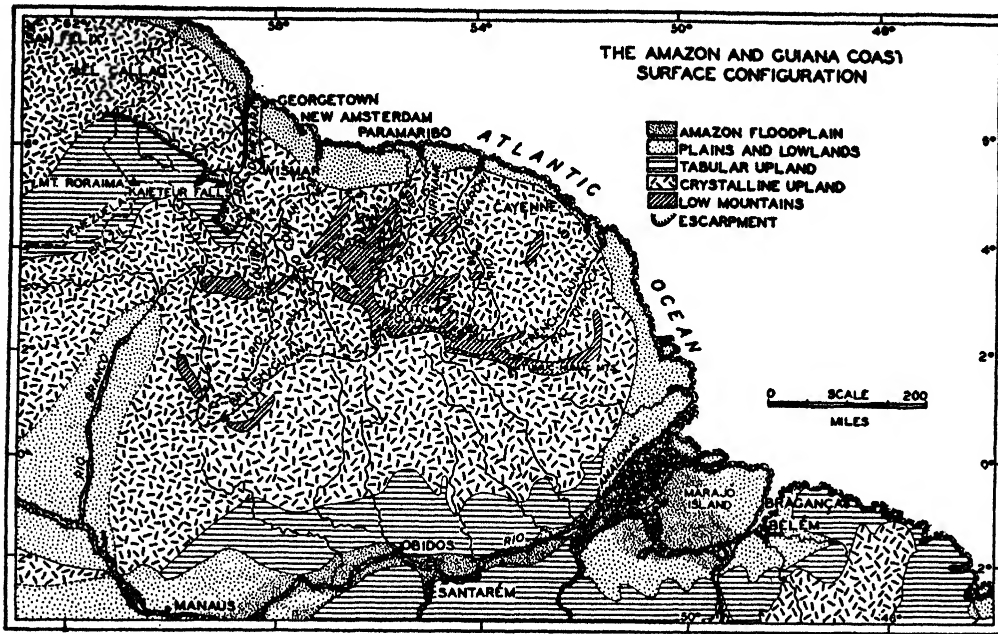
*Caatingas.* — Vegetação formada de cactaceas e arvores, geralmente, de pequeno porte. Compreende os Estados nordestinos. Aí é a região onde as secas ocorrem com mais frequencia causando calamidades e vexames para as populações locais e preocupando o governo. É zona de criação de gado e lavoura de algodão. Ocorrem a carnaúbeira, a oiticica, o caroá, que fornece uma fibra de primeria ordem, e os frutos oleaginosos.

*Babaçuais.* — Predomina a palmeira Babaçú, classificada pelo grande botanico BARBOSA RODRIGUES, de *Orbignia speciosa.* Abrange os Estados do Maranhão, Piauí e Goiaz. No Estado do Maranhão, onde existem as maiores ocorrencias de *Orbignia speciosa,* estas ocorrencias começam perto do Turi-Açú, compreendendo o curso medio dos rios Pindaré, Grajaú e Mearim e por ultimo quasi todo o Itapicurú. Os babaçuais são formações hidrofilas.

*Vegetação litoranea.* — Compreende a estreita

Grande do Sul, Paraná, Santa Catarina, São Paulo, Minas Gerais e Pernambuco e Paraíba as condições ecologicas permitem o cultivo dessa graminea. Convem não esquecer tambem as excelentes condições do Estado de Goiaz para a cultura do trigo. Atualmente ha uma area cultivada de trigo aproximadamente de 230, 210 hectares, com um rendimento medio de 700 kilos por hectare. No ano de 1941 o Brasil importou 894.905.015 kilos de trigo. Em 1938 essa importação atingiu a 1.037.169.694 kilos.

O Ministerio da Agricultura está instalando varios campos de cooperação da cultura de trigo para fomentar a sua produção. Segundo calculos recentes no Brasil ha uma area triticola equivalente a 63.484.000 de hectares. Em 1941 o Brasil produziu 180.449.400 kilos de trigo proveniente das culturas feitas nos Estados de Pernambuco, Baía, Espirito Santo, Paraná, Santa




(*De* JAMES's Latin America, Nova-York, 1942)

Catarina, Rio Grande do Sul, Mato Grosso, Goiaz e Minas Gerais.

*Milho.* — Este cereal representa 17% do valor total da safra agricola do Brasil, que está colodo mundo. É artigo de exportação. Em 1938, o Brasil exportou 120 mil toneladas de milho. Em 1941, a produção de milho alcançou um volume de 84.813.417 kilos. A cultura do milho estende-se por todos os Estados brasileiros.

*Arroz.* — O Brasil é o paiz por excelencia para a cultura do arroz. Nos Estados do Rio Grande do Sul e S. Paulo a plantação desse cereal é feita obedecendo os mais rigorosos preceitos da tecnica. No primeiro daqueles estados ha o Instituto do Arroz, entidade que controla, orienta, e dirige a produção, a industria e o comercio dessa graminea. É artigo de exportação. Em 1941, o Brasil produziu 23.043.390 sacas de 60 kilos de arroz.

As variedades cultivadas são conhecidas pelos nomes de dourado, matão, japonês, carolina, branco, paulista e honduras.

O Ministerio da Agricultura acha-se empenhado, atualmente, em resolver o problema da cultura do arroz no vale do rio São Francisco e no Estado do Maranhão, onde existem grandes tratos de terra propicia ao seu cultivo.

*Cevada.* — Comquanto ainda seja pequena a produção de cevada no Brasil tem este país condições favoraveis ao seu desenvolvimento cultural e industrial sobretudo nos Estados do Rio Grande do Sul e Paraná.

*Centeio.* — A produção do centeio está concentrada nos Estados do Rio Grande do Sul, Santa Catarina, Paraná, e São Paulo. Em 1941 o Brasil produziu 15.033.290 kilos de centeio.

*Aveia.* — A aveia encontra grandes possibilidades de cultura nos Estados meridionais do país. Em 1941, o Brasil produziu 8.344.380 kilos de aveia.

*CAFÉ:* — O Brasil é o maior produtor de café do mundo. Os Estados que mais produzem esta rubiacea são os de S. Paulo, Minas Gerais, Espirito Santo, Paraná e Estado do Rio. Existem no Brasil 2.511.000.000 cafeeiros cobrindo uma area de 3.492.000 hectares. Em 1941, os Estados Unidos importaram do Brasil 9.930.970 sacas de 60 kilos de café em caroço.

*FUMO:* — O Brasil possue excelentes terras para a cultura do tabaco. O Ministerio da Agricultura mantem duas estações experimentais da cultura do fumo, uma no Estado do Pará e outra no Estado da Baia. Em 1941 a produção de fumo atingiu a 91.431.270 kilos.

*ALGODAO:* — O Brasil atualmente é um dos maiores produtores de algodão do mundo.

Em nenhuma outra parte da superficie do globo medra o afamado algodão chamado Mocó (*Gossypium vitifolium*) que encontra seu habitat natural na região do Nordeste. É um algodão de fibra longa, perene, contrastando com as demais variedades anuais.

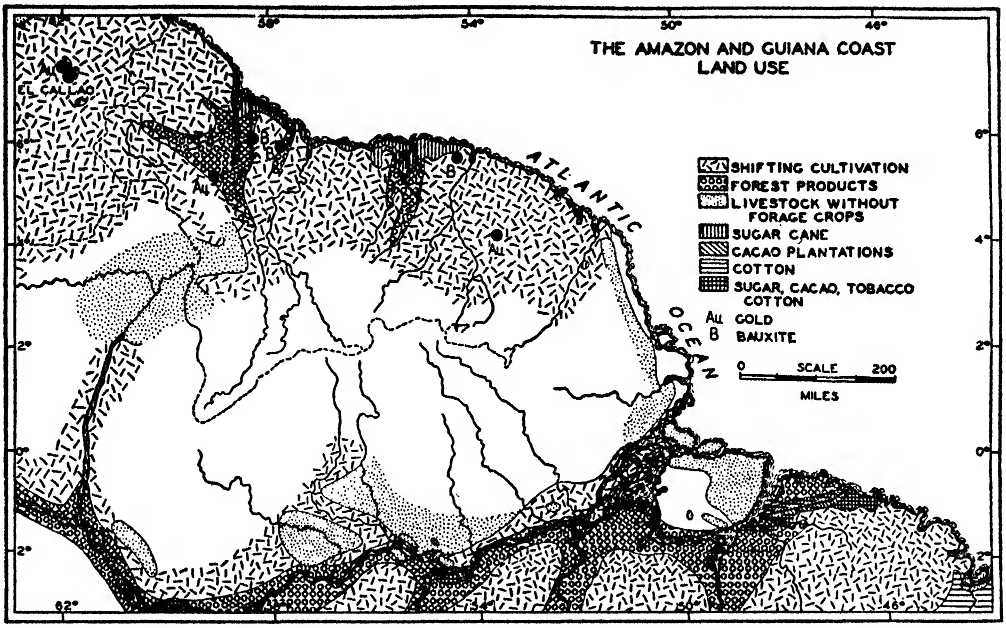
Algumas veses o algodão chamado Mocó dá uma fibra de 40 milimetros de comprimento. Geralmente as sementes desse algodão são pequenas e de cor quasi preto, núas e com a forma de uma pêra. Sua fibra presta-se admiravelmente à fabricação de tecidos finos.

No Estado de São Paulo, que é hoje o maior produtor de algodão no Brasil cultivam-se as variedades anuais, taes como o Texas, o Delfos e o Piratininga.

No Estado da Paraíba do Norte está sendo feito o cruzamento de varias especies com o fim de obter melhores e mais longas fibras. Este trabalho está a cargo da Estacão Experimental de Plantas Texteis, no municipio de Ibiapinopolis.

No Norte do Brasil cultivam-se ainda as seguintes variedades conhecidas vulgarmente pelos nomes de "Rim de Boi," "Riqueza" ou "Verdão," e "Mocozinho."

O Brasil, pelas suas especiais condições de solo e clima, é o país fadado a produzir algodão dos melhores tipos e qualidades.




(*De* JAMES's Latin America, Nova-York, 1942)

De ano para ano, vem se desenvolvendo essa lavoura e colocando-se numa posição de grande destaque entre os demais paises produtores dessa malvacea. Merece especial mensão o trabalho cientifico a cargo do Instituto Agronomico de Campinas, no Estado de São Paulo, com o fim de fixar variedades permitindo que as culturas algodoeiras no Estado sejam feitas debaixo de um alto rigor de tecnica agricola.

Em 1941, o Brasil produziu 510.000 toneladas de algodão. Com a guerra de 1939, o país perdeu importantes mercados na Europa e no Oriente, mas, em compensação, ganhou outros mercados e conseguio colocar dentro do proprio país grande parte de sua produção, com o desenvolvimento que tomou a industria de tecidos.

*FIBRAS TEXTEIS:* — O Brasil é um vasto manancial de fibras texteis, algumas nativas que só existem medrando nas terras brasileiras. O Caroá, por exemplo, é um dessas fibras que tem por *habitat* natural a região do Nordeste. Tratase de uma bromeliacea, conhecida pelo nome cientifico de *Neoglaziovia variegata.* Existe em estado nativo nos Estados da Baía, Pernambuco, Paraíba, Rio Grande do Norte e Piauí. Está sendo industrializada com extraordinario sucesso para a fabricação de fios de vela, fios para sapatos, cordão, tecidos para roupas, papel para correspondencia e para copiador.

Alem do Caroá, o Brasil possue a Macambira, o Sisal, os Hibiscus, taes como a Papoula de São Francisco, a Juta Paulista etc.

*SEMENTES OLEAGINOSAS:* — É conhecida a possibilidade do Brasil como país rico em sementes oleaginosas sobretudo na região do Amazonas. Entre outros oleos vegetais citam-se o de Oiticica, Babassú, Algodão, Batiputá, Amendoim, Girasol, Gergelim, Macaúba, Sapucaia, Mamona, Seringueira, Uchi-Pucú, Umari, Mucujá, Murumurú, Urucuri, Inajá, Bacaba, Copaíba, Dendê, Curuá, Fava de Arara, Cajú, Piquiá, Piqui, Cupuaçú, etc.

*CACAU:* — O Brasil é o segundo produtor mundial de Cacau, que é produzido nos Estados do Pará, Pernambuco, Baía, Espirito Santo, Rio de Janeiro, Minas Gerais e Amazonas. A Baía é o Estado de maior produção. O Instituto do Cacau, em S. Salvador, é o orgão controlador da produção, industria e comercio.

O Brasil produz ainda Chá, Herva-Mate, Feijão e Fava, Guaraná, Mandioca, Timbó, Bananas, Laranjas, Limas, Limões, Grape-Fruit, Uva, Abacaxí, Mangas e uma variedade enorme de frutos.

*CANA DE AÇUCAR:* — A cultura dessa graminea é tradicional no Brasil. Atualmente o trabalho experimental tem melhorado consideravelmente os canaviais brasileiros com a introdução de novas variedades resistentes às molestias e de maior rendimento cultural. Em Pernambuco, sobretudo, existem as mais adeantadas usinas de fabricação de açucar e o Ministerio da Agricultura mantem duas grandes Estações Experimentais de Cana de Açucar, no Estado do Rio (Campos) e no Estado de Pernambuco (Curado).

*BORRACHA:* — O Brasil é, na sua região Amazonica, o *habitat* natural da Seringueira que produz a Borracha, tão necessaria no esforço de guerra. O Instituto Agronomico do Norte, em Belem, Pará, está realizando estudos tecnicos concernentes à produção da *Hevea brasiliensis.*

EMBAIXADA DO BRASIL,
WASHINGTON, D. C.

PAULO F. SOUZA: **The Brazilian Forests:** — *History.* — It is a well known fact in history that the exploration of Brazilian forests began immediately after the discovery of Brazil, perhaps even before that time, if we are to lend credence to BRANDÃO's navigations in 1343 and those by PINZÓN in January, 1500, and to geographic charts prepared previous to CABRAL's voyage. A true fact is that AMERICO VESPUCIO, in 1501, and GONÇALO COELHO, in 1503, carried to Portugal, for the Portuguese Crown, large

quantities of "braza" (live-coal) coloured wood (Ibira-pitanga—red wood in indigenous language) and hence the name "Brazil"; this wood immediately became an important article of trade, the monopoly of which was awarded by the King of Portugal to the adventurer FERNÃO DE NORONHA who, during the year 1519 only, felled 5,000 trunks and shipped them to Portugal. The monopoly relative to Brazil wood ("pau brasil") was discontinued only in 1605.

During a century and a half, the forests of Brazil were ravaged, until in 1652 a protest was raised against such abuse, which, however, was not repressed until 1751, when, by virtue of representations to the Crown, the first measures were adopted to limit the felling of hardwoods.

As we are aware, Portugal always protected its forests, since the time of D. DENIS (1261-1325), founder of the University of Coimbra and of the "Pinhal da Leiria" (Leiria pinetum), the history of which has been masterly written by Forester A. ARALA PINTO, in his book "O Pinhal do Rei" (The King's Pine Trees), Alcobaça, Portugal.

Many countries of Europe, several centuries ago, already protected their patrimonial forests. Thus—Spain in 1184, Germany in 1400, Austria in 1512, Italy in 1600, France in 1669.

Portugal followed the most advanced civilization of the times, and hence its vast forest legislation, applicable in part to Brazil. As proof of this, there is the "Corte de Madeiras" (The cutting of woods), published on October 19, 1789, by Desembargador FRANCISCO NUNES DA COSTA, "Inspetor dos Reaes Cortes da Capitania da Baía," regarding the necessity of acquiring appropriate ships to transport woods from different points to the shipping center, where they were stored for subsequent shipping to the Kingdom.

In 1795 the Botanical Garden of Portugal was created; Brazil had its Botanical Garden, which still exists and in the same place (Fazenda da Lagoa), by official permission of March 1, 1811, a large arboretum was created for exotic plants such as "moscadeiras," "alcanforeiras," "cravos da India," cinnamon, pepper, and cochineal cactus, and for the plantation of artificial forests of hardwoods, such as "peroba," "tapinhoans," "canelas," "vinhaticos," etc., and finally directing and promoting the formation of good pastures for the feeding of the cattle of the farm and all other articles relative to good agriculture.

Long before this, however, in 1779, the Queen of Portugal gave orders to have reserved, as belonging to the Royal Crown, all woods and trees on the coast line or bordering navigable rivers, of the old uncultivated lands. This measure extended to the "Capitanias" of Paraiba, Baía, and Rio Grande do Sul. The orders were severe and included the demarcation, without loss of time, of the woods existing along the coast and navigable rivers flowing into the sea, and had the following objectives in view: 1) the preservation of the forests and trees; 2) economy as regards cutting and transportation; 3) to facilitate remittances, and 4) the establishing of a perfect accounting showing the price of each piece taken from said trees and forests. These data were to be forwarded together with the greatest possible quantity of samples of existing woods. The royal letter, addressed to the Captain General of the "Capitania" of Baía, instructed that such work should also be done as regards the forests of Alagoas and Cairú and those of Rio Doce in the Espirito Santo Capitania, where the felling of some trees should take place for the investigation of the principal woods which might be felled with profit, taking the utmost care, however, to prevent private parties from indulging in excess as regards the cutting of wood in an attempt to export same.

In the same year, 1799, the Queen issued the Regulation of the Cuttings of the Woods for the Pernambuco and Baía Capitanias and limited the forests of the Royal Crown by the Comarca de Ilhéos, Rio Taipe, etc., up to the forests of Pau Amarelo and Rio Pitangi Grande, which border upon the "caatingas" of the interior of the country. From this it is inferred, in a passing manner, that the northern "caatingas" (caa—forests, tinga—white) already existed at that time (1799) as a result of ecological conditions and not as a consequence of devastations or fires as one is erroneously led to believe, *i.e.* that men are solely responsible for the careless destruction of forests of that region.

As a complementary measure for the safeguarding of the woods and lumber belonging to the Crown, the regulation also covered the following: only the wood unfit for construction could be taken from the reserved forests; the felling of "pau brasil" was absolutely forbidden; Jequiriçá, Baía, and Belmonte de Porto Seguro were under the jurisdiction of the Judge in charge of preserving the Ilhéos Woods; all lumber would carry a letter - R - (Royal) indicating the place from which it originated, there still exist iron stamps for the date and numbering of the logs; fines in money, and imprisonment were imposed upon those guilty of infraction of the royal wishes, aside from the loss of the cattle, vehicles, slaves and hardware found in the woods; the felling could take place only at proper times, also the necessary drying chiefly of "sucupiras," "jatáis," "angelins," "paus d'arcos," "vinhaticos," "potumuius," "tapinhoans," "oitis" and "cedar" trees; the work took place daily from 6 to 12 and from 2 to 6 p.m.

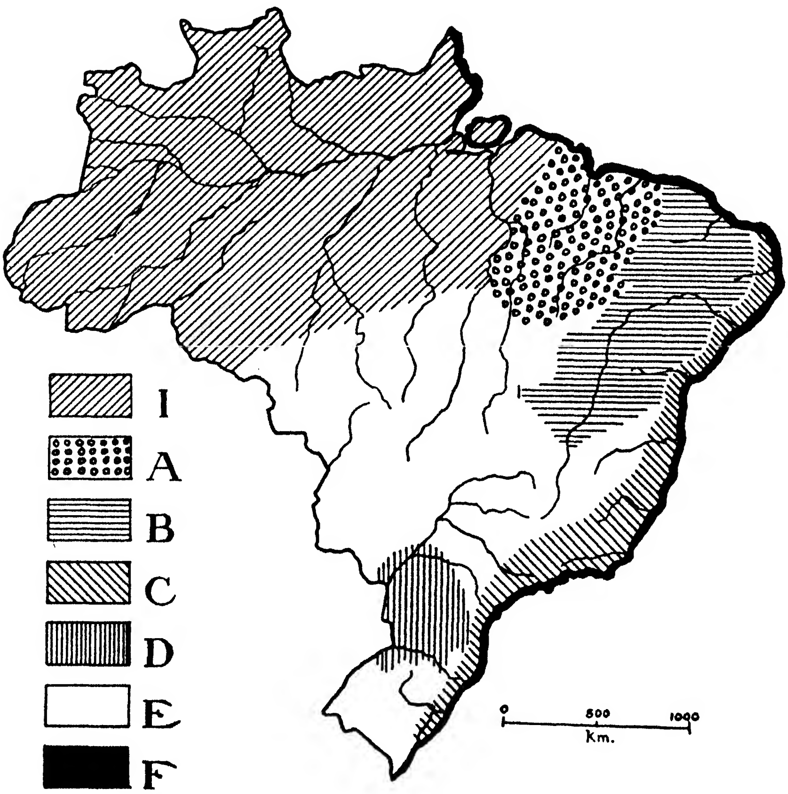
From that time on until the independence of Brazil, in 1822, several steps from royal origin were taken such as: the cutting of fuel wood for sugar mills; extracting of quinine; planting of "amora" trees; contract for the services of the botanical expert KANCKE to describe the plants of Brazil; the granting of privileges to those who would introduce and cultivate spices from India and other exotic plants; granting of special licenses for the cutting of "pau brasil;" forbidding cattle from grazing in woods in the neighbourhood of farming lands; regulating the felling of "pau brasil" in the Provinces of Rio de Janeiro and "Capitania" of Espirito Santo; appointment of an inspector for the cutting of construction wood in the Island of Santa Catarina, etc.

In 1822 Brazil became independent from Portugal. D. PEDRO I took charge of the government as Emperor, up to 1831. The following measures were adopted at that time: Dissemination of the plants cultivated at the Botanical Garden of "Lagoa Rodrigo de Freitas"; the installation of plant-gardens in Baía, Pará, Cuiabá, Sergipe, Olinda, and São Luiz do Maranhão; the printing of the "Flora Fluminensis" of Frei JOSÉ MARIANO DA CONCEIÇÃO VELLOSO; the printing of Frei LEANDRO's memoirs regarding the planting, cultivation and preparation of tea; regulating the trade in "pau brasil" with

England; the weeding and tree-felling in unoccupied tracts of land; the cutting of "mangue" (mangrove) leaves for tanneries; regulating the cutting of wood in the Province of Alagoas and Santa Catarina.

In 1831 D. PEDRO I left for Portugal and his son D. PEDRO II, only 5 years of age, took his place. During his extended period of government, including the minority period (1831-1841), the following measures relative to forestry were adopted: Recommendation relative to the cultivation of mate in the southern provinces of the Empire; declaration relative to the extinction of the "estanco" of "pau brasil"; issuance of instructions for the observance of police regulations in the Botanical Garden of Rio de Janeiro; granting of privilege to HENRY LEE NORRIS to introduce into the Empire a method of immersing timber in chemical preparations in order to make it stronger, incorruptible and lasting; establishment of methods for the cutting of wood; preparation of vegetable coal (charcoal); harvesting of herva mate, etc.

*Geographic Distribution.* — For a detailed study of the Brazilian forests and their geographic distribution it is indispensable to have a knowledge of the most important works heretofore published. The most valuable is doubtless that of MARTIUS (CARLOS FREDERIC PHILIPE VON MARTIUS, 1794-1868), composed of 40 volumes, and including 2,253 genera, 22,767 species, and 3,811 pictures. This truly monumental work, covering not only Brazil but also some neighboring countries, was written during 66




FOREST ZONES OF BRAZIL.—I, Silva Amazonica; A, Palm Forest; B, Caatingas; C, Eastern Coast Forest; D, Pine Forest; E, Campo (Prairie); F, Maritime Zone.

(1853) to manufacture liquid rubber by means of a chemical process invented by him; instructions for the observance of regulations relative to the cutting of woods for naval construction in the Province of Pará; granting of privilege for 10 years to Dr. GUILHERME CAPANEMA to manufacture paper with indigenous vegetable fibres; instructions for the planting and preservation of Tijuca and Paineiras forests; granting authorization to "Companhia Florestal Paranaense" (Paraná Forestry Company) to operate in the Country; approval of the statutes of "Associação Anonima Centro de Exportação de Herva Mate do Rio Grande do Sul" (Anonymous Association-Mate Export Center of Rio Grande do Sul); granting of privilege to JOSÉ MARIA DA PAIXÃO

years by 65 botanical experts, under the successive direction of MARTIUS, ENDLICHER, EICHLER, and URBAN, and under the patronage of the Emperor of Brazil, of the King of Bavaria, and of the Emperor of Austria.

MARTIUS classified our forests in five provinces or sub-kingdoms, according to mythologic divinities and which, geographically, are as follows:

*Naiads* (régio denique callida humido)—embracing the Amazonas and Pará regions, named from the nymphs presiding over rivers and fountains.

*Hamadryads* (régio extra tropico et callida sicca)—comprising Maranhão, Piauí in part, Ceará, Rio Grande do Norte, Paraiba, Pernambuco, Baia in part, Sergipe, Alagoas, Minas, and Goiás in part, named from the nymphs whose lives were connected with the trees.

*Oreads* (régio montano-campestri). — comprising: Baia's central part, Minas, South of Goiás and Mato Grosso, and almost the whole of São Paulo, named from the nymphs who accompanied Diana, the hunting goddess.

*Dryads* (régio montano nemorosa) — including the oriental part of the present States from São Francisco River in the North down to the city of Iguape in the South, named from the nymphs in charge of the woods.

*Napaes* (régio extra-tropico) — comprising the Southern States — Paraná, Santa Catarina and Rio Grande do Sul, named from the nymphs who protected the valleys and meadows, as well as the plants existing thereon.

The classification of MARTIUS embraced two more provinces or complemental sub-kingdoms; Brazilian gaps and extra-Brazilian gaps, referring to certain plants which do not grow spontaneously in several zones of the territory and to the plants of adjacent countries also found in the center of our territory.

CAMINHOÁ (JOAQUIM MONTEIRO CAMINHOÁ, 1836-1896), author of "Elements of General and Medical Botany" and BARBOSA RODRIGUES (JOÃO—1909), author of many works on botany, suggested alterations in MARTIUS' system for the classification of the Brazilian forests.

Recently, however, A. ENGLER, in "Syllabus der Pflanzenfamilien," 10th edition, 1924, and M. RIKLI, in "Geographie der Pflanzen," established an international system, condensing the most modern geo-botanical knowledge, including that of the Brazilian Flora.

Works on the classification of the Amazon forests which should be mentioned are: HUBER, "Matas e Madeiras Amazonicas—1909" (Woods and Timbers of the Amazon—1909) and "Rubber Production in the Amazon Valley" by SCHURZ, HARGIS, MARBUT and MANIFOLD, Trade Promotion Series No. 23, Washington, D.C., 1925.

HUBER adopted in his work the following forest disposition: "Mangues" (Mangrove), "Varzeas" (Bottom Lands—subject to periodic inundation)—high and low, "Igapós" (Swamp forests), and "Terra firma" (Upland —level plain or undulating and rolling land)—comprising the forests of the region covered by the Bragança Railway, the General Forests of the Southern part of the State of Pará, the Central Forests of the former so-called "Contestado" (disputed land), the Forests of the Northern Plains in the Low Amazon, and the upland forests of the High Amazon.

The American Committee in charge of the study of rubber in the Amazon Valley established the following division: 1) Islands of the Estuary, 2) Southern Low Amazon, 3) Northern Low Amazon, 4) Northern High Amazon, 5) Madeira River, 6) Southern High Amazon, 7) Acre Territory, 8 & 9) Bolivia, Peru, Ecuador and Colombia.

Professor SAMPAIO (ALBERTO JOSÉ) of the National Museum of Rio de Janeiro, a recognized authority on these subjects, suggested a slight alteration in the above mentioned systems.

ENGLER'S system consists of two great divisions or provinces as follows:

I—The "Provincia Amazonica" (Amazonian Province) or "Flora Amazonica ou Hylaea" (The Flora of the Amazon or Hylaea).

II—The "Provincia Extra-Amazonica ou Flora Geral" (The Extra-Amazonian Province or General Flora).

The Flora of the Amazon comprises HUMBOLDT'S Hylaea, *i.e.* the immense equatorial, humid forest of the Amazon River and the rivers flowing into it, with an approximate surface of 3,5 million square kilometers, or 40% of the territorial surface of Brazil.

The vegetation of the Amazonian Forests is divided in two characteristic types: Upland Forests—elevated land (90% or more of the land area) not subject to inundation from the overflow of the rivers, and Forests of the Varzeas—bottom lands, periodically flooded during the rainy season. Fields and prairies are included in these two types of vegetation.

From a geographic point of view, the basin of the Amazon is divided into two regions: Baixo Amazonas (Lower Amazon), which extends from Rio Negro through Manaos down to the estuary, and Alto Amazonas (Upper Amazon), which extends from Rio Negro up to heads of all the affluents of the Amazon River.

The "Provincia Extra-Amazonica ou Flora Geral" (extra-Amazonian Province or General Flora) is larger than the previous one, being 60% of the territorial surface of Brazil and comprises: (a) Palm-Zone of the Middle North, (b) "Caatingas" of the Northeast, (c) Coast Forests or Oriental Forests, (d) Pine Forests, (e) Prairies, and (f) Maritime Zone.

*Amazonian Province or Amazonian Flora.*— The principal types of Amazonian Forests are characterized by the hydrographic system to which they belong.

Thus, on the coast and along the rivers subject to the flux and reflux of the seas, there is found the "Mata das Aluviões Maritimas" (Sea-inundated Forests) called "Mangue" (marshy land) which embraces few species, common to the coasts of America and Tropical Africa.

The next is "Mata das Aluviões Fluviaes-Varzeas" (Bottom land Forests—low ground subject to annual overflow) which extends along the Amazon River and all its affluents, from Belem to the Andes. Their floristic composition is more varied.

Lastly, the "Mata de Terra Firme" (Upland Forests), displaying an extremely varied vegetation, notwithstanding its apparent uniformity.

"Mata das Aluviões Maritimas" (Sea-inundated Forests). This is the vegetation of least importance. The marshy lands (mangrove) which occupy an area of relative insignificance, as to the type of vegetation, at the mouth of the Amazonas and on the Atlantic Coast, comprise the following: The true "mangue" (*Rhizophora mangle*), the "ciriuba" (*Avicennia nitida*) and the "tinteira" (*Laguncularia racemosa*). At the North and South of the coast of Pará there appear two species which are commonly found in the American marshy lands — *Conocarpus erectus* and *Bucida buceras*.

As regards plants growing in the marshy lands the following are cited: "mututi" (*Pterocarpus draco*), "envira" (*Hibiscus tiliaceus*) and "araticú" (*Anona palustris*).

The marshy land may be more or less unmixed, *i.e.* represented by only one of the above mentioned species, or composed of two or more of them. The average height of the vegetation of the "mangal" is from 10 to 15 meters. It is a known fact that at present the "mangue" trees are not considered among us as an important economic factor, although the bark contains a high percentage of tannin good for tanneries.

The marshy lands subject to daily sea-inundation cannot be easily inhabited, due to the muddy soil.

The "Mata das Aluviões Fluviaes-Varzeas" (River-Inundated Forests — bottom lands, subject to annual overflow) is the typical vegetation of the Amazon. It extends along the Amazon River and all its affluents.

The margins of these affluent rivers are low and the adjacent lands are easily flooded. The extension of the areas subject to such floods varies from a few meters to hundreds of kilometers. Such lands should not be confused with the low lands of the Amazonas estuary which are subject to the influx of the seas, which are of more consequence than the river floods.

The forests of the bottom lands or "varzeas" grow in soil rich in sediments, hence their exuberant and rich vegetation.

Such rich vegetation, however, is not so pronounced in the forests of the Low Amazonas as exactly in such regions there appear extended beaches, preceding the woods, in which grow the "oeiranas" (*Salix Martiana* and *Alchornea castaneifolia*), the "imbauba" (*Cecropia* sp.), the "munguba" (*Bombax munguba*). The typical tree of the "Mata de Varzea do Rio Amazonas" (Bottom Lands Forests of the Amazon River) is the "Tachi" (*Triplaris surinamensis*).

The following trees frequently grow in this forest formation: "andiroba" (*Carapa guianensis*), "murupita" (*Sapium lanceolatum*), "genipapo" (*Genipa americana*), "paraparà" (*Cordia tetrandra*), "taperibá" (*Spondias lutea*), "ucuuba" (*Virola surinamensis*), "macacaúba da varzea" (*Platymiscium Ulei*), and others.

The undergrowth is relatively poor, consisting of creepers of short duration.

Near the estuary of the Amazonas River the palm-trees are represented by about 20 species, and in the bottom lands or "varzeas" of the Low Amazon there will be found only about 5 or 6. The more important are: "jauari" (*Astrocaryum jauari*), "murumurú" (*Astrocaryum murumurú*), "urucurí" (*Attalea excelsa*), and some *Bactris* types.

The relative poverty of the "varzeas" or bottom lands is a result of the area occupied by extensive fields which lay in surface depressions, alternately forming shallow lakes which dry easily and become pasture grounds. These fields are found near and far from the river beds. The latter case is observed on the borders of the State of Pará where the "varzeas" are more exuberant. We find there the following types: "muiratinga" (*Olmedia maxima*), "pau mulato" (*Calycophyllum Spruceanum*), "caxinguba" (*Ficus*-sub-genus *Pharmacosycea*). In such forests the underwood is not so poor.

The "varzeas" of the High Amazonas, starting at the mouth of the Rio Negro (Black River) near Manaos, up to the heads of the rivers of that immense area, preserve their marked features of luxuriant vegetation, lands which crumble down due to the undermining of the margins, the appearance and disappearance of groups of vegetation, etc. Near the water grows the "oeirana" (*Alchornea castaneifolia*), then follow the "imbauba" (*Cecropia* sp.), sometimes forming unmixed forests, "imbaubal," of rapid growth and thin tops, thus permitting the growing of other plants of denser and darker foliage, such as the "louro da varzea" (*Nectandra amazonum*), the "tachis" (*Triplaris* sp.), the "mutamba" (*Guazuma ulmifolia*), the "assacú (*Hura crepitans*), the "pau mulato" (*Calycophyllum Spruceanum*), the "jauari" palm (*Astrocaryum jauari*). These plants grow rapidly so that in 10 years they are higher than the "imbaubas" under whose shade they have grown. Within a short period the "imbaubas" are dominated and disappear, there remaining only the luxuriant forests made up of the above-mentioned species, increased by some other types, but made up chiefly of "jauari" palm trees, which, undoubtedly, occupy the greater part of the "varzeas," of "tachi," "munguba" and "pau mulato." The latter sometimes forms almost pure forests, as in Rio Ucayali.

From all plants found in "varzeas" or bottom lands unquestionably the most important is the "seringueira" (*Hevea brasiliensis*).

The "seringueira" is frequent in the islands and small affluents of the estuary, it is missing on the "varzeas" of Low Amazonas and again reappears at the middle and higher courses of the right-hand margin affluents, and even dominates in certain regions as in the Acre Territory. In some places, where the "varzeas" begin to rise as in a transition to upland, better forests are found. These higher "varzeas," common at the Rio Purus, are characterized by the "urucurí" palm (*Attalea excelsa*) and by the frequent growth of the following trees: "cumarú" (*Coumarouna odorata*, var. *tetraphylla*), "sumauma" (*Ceiba pentandra*), "muiratinga" (*Olmedia maxima*), "cedro" (*Cedrelá* sp.), "jataí" (*Hymenaea* sp.), "copaíba" (*Copaifera* sp.), "tauarí" (*Couratari* sp.), "castanha de macaco" (*Couroupita subsessilis*), "assacú" (*Hura crepitans*).

In this group of vegetation, the "pau mulato" and the "seringueira" are not so abundant, but their development reaches the maximum and the forests as a whole reach an average height of 40 meters, whereas in other "varzeas" the average height is 30 meters.

The forests of the higher "varzeas" form real tiers or stories of vegetation — on the top, the above mentioned plants; on the lower story, 20 to 30 meters, there are found several species of *Sapium, Virola, Cordia, Inga, Rheedia, Triplaris, Cecropia, Cassia, Plumeria*, etc., and lower still there are found small trees and bushes — *Rubiaceae, Solanaceae, Myrtaceae, Sterculiaceae, Caricaceae*, etc., and many herbaceous plants cover the ground. The lianas are very frequent in these "varzea" forests.

The palm tree "jauari," typical of the low "varzeas," disappears from the higher "varzeas," giving place to the "urucurí," the fruits of which are used in the smoking of latex.

It is perfectly well known today that the "seringueira," the "urucurí" and the "murumurú" form a true vegetative association. These palm trees grow everywhere along the Amazonas River and the affluent rivers.

The "assaí" of the High Amazonas (*Euterpe precatoria*) is different from the Pará "assaí." In the latter State, the "assaí" forms stumps and in the former the stipes are isolated.

In almost all the high "varzeas" of the High Amazonas there are also found the following palm-trees: "pachiuba" (*Iriartea exorrhiza*), "bacabinha" (*Oenocarpus multicaulis*), several kinds of *Attalea, Pyrenoglyphis, Taenianthera* and the "jarina" or vegetable ivory (*Phytelephas macrocarpa* and *microcarpa*).

"Igapó." — This in indigenous language signifies forests full of water or forests where the water remains stagnant during a long time, owing to the fact that there is no sufficient natural outlet for it. The typical trees of the "igapó" are: "jacareúba" (*Calophyllum brasiliense*), "arapari" (*Macrolobium acaciaefolium*), "abiurana" (*Lucuma* sp.), "louro do igapó" (*Nectandra amazonum*), "piranheira" (*Piranhea trifoliolata*), "ingá" (*Inga* sp.), "geniparana" (*Gustavia augusta*). The lianas are rarely found in the "igapó." As a compensation, the "epifitas" are very frequent.

The river waters, in this region, are generally rich in sediments. However, there are some rivers which contain little sediment. Among these the principal one is the Rio Negro, which flows through Manaos. It has been observed that the vegetation of the "varzeas" varies slightly in relation to the larger or smaller quantity of sediments in the different water courses.

The influence of men has been scarcely felt in the floristic composition of the Amazon.

In the islands, the extracting of rubber, notwithstanding its depreciation, is still the chief occupation of the inhabitants. The small farms of the rubber extractors, when abandoned, in a short time disappear under the vegetation which grows on them, forming shrubberies without floristic characteristics.

The influence of men is felt in the bank reefs of the Low Amazonas, where they utilize, for the cultivation of cacao, a narrow strip, called "restingas," near the rivers. The cacao plantations are generally shaded by "imbaubas" and sometimes by "seringueiras" (rubber trees).

The small farms are always near the dwelling places.

We will now refer to the "Matas de Terra Firme" (Upland Forests), *i.e.* the forests which are not subject to river inundation.

It is not easy to give an exact picture of these forests, inasmuch as their exploration has been carried out to a lesser degree than the "varzea" or bottom land forests, as the latter are of easier access to men, who go over them constantly in extracting rubber.

The first knowledge of the Upland Forests started with the searching for "caucho" (*Castilloa Ulei*), and from then on to the present they continued to be explored for the woody fruits of the "castanheira" (*Bertholletia excelsa*), which trees are characteristic of the higher forests.

By the above descriptions of the different Amazonian forests, it is easily understood how irregular the distribution is of the upland forests over this vast region and hence the lack of detailed data relative to their exact

composition and extension and also that of the fields or open grasslands.

The most important upland forests are designated in accordance with the region in which they are located.

The forests of the "Bragança Railway," possessing few "castanheiras" and "caucho," are rich in hardwoods such as: "acapú" (*Vouacapoua americana*), "pau-amarelo" (*Euxylophora paraensis*), "pau santo" (*Zollernia paraensis*), "massaranduba" (*Mimusops* sp.), "jarana" (*Chytroma* sp.), "matamatá" (*Eschweilera* sp.).

Belém, capital of the State of Pará, has been supplied with woods for various purposes from the region denominated "Mata Geral da Região Oriental do Pará" (General Forests of Pará Oriental Region), embracing the whole region between the ocean and "Gurupi" River, on one side, and the "Tocantins" and "Pará" Rivers on the other side.

Another upland forest with an approximate extension of 5 geographic degrees, is located between the "Tocantins" and "Tapajoz" Rivers, known as "Mata Geral da Parte Meridional do Estado do Pará" (General Forests of the Southern Part of the State of Pará). These forests are exceedingly rich in "caucho" and "castanheiras" (Brazil-nut trees).

The other forests of great value due to their timbers are as follows: "Mata Central do Antigo Contestado" —grandes campos inclusos (Central Forests of the former disputed land—extensive fields included), "Matas dos Planaltos ao Norte do Baixo Amazonas" (Forests of the Northern Plains of the Low Amazon), and "Matas de Terra Firme do Alto Amazonas" (Upland Forests of the High Amazon).

The general composition of these forests is as follows: "muirapinima" (*Brosimum guianensis*), "acapú" (*Vouacapoua americana*), "tatajuba (*Bagassa guianensis*), "louros" (*Ocotea* sp.), "itauba amarela" (*Silvia itauba*), "macacauba" (*Platymiscium Duckei*), "sucupira" (*Bowdichia virgilioides*), "pau amarelo" (*Euxylophora paraensis*), "marupá" (*Simaruba amara*), "cedro" (*Cedrela* sp.), "andiroba" (*Carapa guianensis*), "ipés" (*Tabebuia* sp.), "piquiá" (*Caryocar villosum*), "sapucaia" (*Lecythis paraensis*), "massaranduba" (*Mimusops amazonica*), "maparajuba" (*Mimusops paraensis*), "freijó" (*Cordia Goeldiana*), "tarumã" (*Vitex* sp.), "copaiba" (*Copaiba* sp.), "muirapiranga" (*Brosimum paraensis*), "umari" (*Poraqueiba sericea*), "cupiuba" (*Goupia glabra*), "pau santo" (*Zollernia paraensis*), "guaruba" (*Vochysia paraensis*).

*General Flora of Brazil or Extra Amazonian Flora.*—This occupies 60% of our territory, comprising six zones as follows:

A—*Palm Zone of the Middle North.* Includes the States of Maranhão and Piauí, which are situated between the amazonian forests, on the Northwest, the "cerrados" on the Southwest, the "caatingas" on the South and on the East, and the Ocean.

On the coast there is a "mangue," a continuation of the Amazonian Flora, described above.

On the beach grows the coconut tree (*Cocos nucifera*), which seems to have been brought by sea currents.

On the plains we have: the great area containing the "babassú" (*Orbignya Martiana*), probably various types, "carnauba" (*Copernicea cerifera*), "buriti" (*Mauritia vinifera*), characteristic plants of the zone, and the "cerrados" composed chiefly of gramineous plants and scattered trees—"mangabeira" (*Hancornia speciosa*), "barbatimão" (*Stryphnodendron Barbatimao*), "piqui" (*Caryocar* sp.), "bacuri" (*Platonia insignis*), "pau pombo" (*Tapirira guianensis*), "faveira" (*Pterodon* sp.), "caraiba" (*Tecoma* sp.), "cajuí" (*Anacardium* sp.).

The "caatingas" of Maranhão do not contain an abundant quantity of *Cactaceae* as is the case with the Northeast "caatingas."

The "capões de mata" (thickets) and the ciliary woods on the North of the State, have the characteristics of the Amazonian Flora and as such were considered up to the present as belonging to the zone of palm trees.

B—*"Caatingas" of the Northeast.* These "caatingas" comprise the Northeast of Brazil and even a part of Central Brazil, through which flow the S. Francisco River and its affluents. The States included are as follows: Piauí (South), Ceará, Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, Sergipe, Baía and Northern Minas, or an area of 1.5 million square kilometers.

The coast of all these States, beginning with Rio Grande do Norte, towards the South, is bordered by a zone of real forests, several kilometers wide, as will be seen later.

MARTIUS, who studied the caatingas, described their vegetation as follows: "Silvae Aestu Aphyllas," as, in fact, all vegetation loses its foliage in summer, with the exception of some plants such as the "joazeiro" (*Zizyphus joaseiro*) and the "imburanas" (*Torresia cearensis*).

The true "caatingas" are characterized by the presence of innumerable *Cactaceae.*

According to the studies made by MARTIUS, LÖFGREN and LUETZELBURG, the "caatingas" are classified as follows: low caatinga, high caatinga, true caatinga or scrubby caatinga, with various types, arid caatinga, mofumbo caatinga, caatinga de barriguda, dirty caatinga, mountain caatinga and arboreal caatinga with three subtypes, the "braunas," "aroeiras" and "angicos" predominating.

The Northeast natives make still other classifications: the caatinga brejada, caatinga carrascal, catingão, sertão, serido, etc.

As regards the wood in the caatingas, extremely hard types of wood of slow growth are found in them, such as: the "barauna" (*Melanoxylon brauna*), "aroeira" (*Schinus* sp.). "pau brasil" (*Caesalpinia echinata*), "angico" (*Piptadenia colubrina*), "jurema" (*Mimosa* sp.), "imburana" (*Amburana cearensis*), "pereiro" (*Aspidosperma* sp.), "joazeiro" (*Zizyphus joaseiro*), "oiticica" (*Clarisia racemosa*), "faveleira" (*Cnidoscolus phytacanthus*), "mofumbo" (*Combretum leprosum*).

C—*Coast Forests or Oriental Forests.* A strip of forests, varying in width up to 300 kilometers wide, runs parallel to the Brazilian coast, from Rio Grande do Norte to Rio Grande do Sul.

These forests practically accompany the wall formed by the "Serra do Mar" (Sea Ridge-of-Mountains) which rises abruptly near the coast to form the interior plateau.

This wall of mountains serves as a condenser of the Atlantic winds, charged with humidity.

At the oriental extreme of the continent, comprising the States of Rio Grande do Norte and Paraiba, the coast forests are greatly depleted due to the fact that supplies have been taken from them since the colonial times, as explained in the historical part of this article.

Through the State of Pernambuco the forest belt is about 50 kilometers wide at the North of the State and about 120 to 150 at the South narrowing afterwards in the States of Alagoas, Sergipe, and Baía, again widening in the State of Espirito Santo, reaching a great width through the large valleys of the Rio Doce and São Matheus rivers.

The forest belt extends through the States of Rio de Janeiro, São Paulo, Parana and Santa Catarina, in the Pine Forests down to Rio Grande do Sul.

In the Amazon, owing to the fact that the ground is more or less level, the trees grow high up in the search for light. In the zone of the palm trees and of the "caatingas," the plants are adapted to the excess of light and in the forests of the Atlantic slope the plants grow very thick and branch out forming very thick tops. The vegetation is exuberant and the best woods are found there such as: "pau brasil" (*Caesalpinia echinata*), "peroba" (*Aspidosperma* sp.), "jacarandá" (*Dalbergia nigra*), "cedro" (*Cedrela* sp.), "cangerana" (*Cabralea cangerana*), "canelas" (*Ocotea* and *Nectandra* sp.), "brauna" (*Melanoxylon brauna*), "vinhatico" (*Plathymenia reticulata*), "cabreuva" (*Myrocarpus fastigiatus*), "angelim" (*Hymenolobium* sp.), "bicuiba" (*Virola oleifera*), "guarantan" (*Esenbeckia leiocarpa*), "ipes" (*Tabebuia* sp.), "sapucaias" (*Lecythis*

sp.), "oleo vermelho" (red oil) (*Myroxylon toluiferum*), "oleo pardo" (brown oil) (*Myrocarpus frondosus*), "jatobá" (*Hymenaea courbaril*), and gigantic "jequitibás" (*Cariniana legalis*), rivals of the Amazon *Bertholletia*.

The original forests have been explored continuously in order to supply the demands of the population, commerce and industry centralized in the principal cities on the coast or in the interior.

D — *Zone of the Pine Forests.* In the South of Brazil the Coast Forests are related with the Pine Forests, by means of transition woods called "Faxinais" which occur chiefly on the plains of the States of Paraná and Santa Catarina.

The Brazilian pine tree, also called "pinho do Paraná" (Paraná Pine) (*Araucaria angustifolia*), occupies the upper story of the Southern Forests of Brazil. In the lower story there grows the "imbuia" (*Phoebe porosa*), largely employed in the industry of furniture. Then comes the "herva mate" (*Ilex paraguayensis*) of which a popular beverage is prepared. Lastly, the shrubs, under-brushes and creeping herbs that cover the ground of the forests.

The zone of the pine trees has many open grass lands.

The pine tree is exploited on a large scale and more than 70% of the exportation of Brazil woods is represented by pine destined to the Republics of Argentina and Uruguay.

To bring this pine zone description to a completion, I quote below what was written by Mr. JOSEPH C. KIRCHER regarding Paraná Pine: "In considering the future of the industry the fact that the total amount of Paraná Pine in Brazil is limited (about 300 billion board feet in commercial stands) must not be lost sight of. If the industry expands rapidly and some provision is not made for the future production of pine simultaneously with the increased cut, the industry sooner or later will give out. It is certain that unless steps are taken soon to reforest much of the land as it is cut over the States of Paraná and Santa Catarina will some day lose their largest industry and much of their prosperity."

E — *Prairies.* There are extensive areas almost bare as to arboreal vegetation. The prairies containing gramineous and herbaceous plants can be either natural or artificial. These in general are called grazing fields or pasture grounds. When the fields have small trees, scattered over them, they are called "cerrados," "cerradões," similar to those in the central plains of Brazil, embracing part of São Paulo, Minas Gerais, Mato Grosso and Goiás. The fields, in all their modifications, are found all over the Brazilian territory, from the Amazon to Rio Grande do Sul. In this State the fields or "pampas" are very extensive and much used for cattle raising.

F — *Maritime Zone.* Comprises the halophilous or littoral flora: "mangues," coconut trees and the vegetation of the sandy hills and islands, which are hardly important in our case.

*Forest Legislation.* — Presumably, the first project of forest legislation studied by the Government of the Republic, not including the dispositions as contained in the Constitution of February 24, 1891, was brought in 1902 to the Chamber of Deputies, through the intermediary of the Government of São Paulo, by Dr. ALBERTO LÖFGREN (1854-1918), who assisted to such a great extent in the study and knowledge of our forest patrimony.

In 1910 the Government issued a decree providing that the Acre Territory would be considered as a National Forest Reserve.

From that time on the Federal and State authorities always considered the necessity of a forest legislation, in order to prevent inordinate devastations which were spreading terribly all over the national territory.

Various States had already adopted measures relative to their forests, as follows:

State of Amazonas — Prohibiting the exportation of seeds of "hevea," "ouricuri," "inajás" and "tucumã"; classification of lumber for export; installation of demonstration fields for the cultivation and exploitation of regional plants; prohibiting the felling of gutta-percha and balata trees.

State of Pará — Establishing prizes for enterprises created for the refining of rubber; regulating the cutting of lumber; steps to increment the cultivation of "timbó" (*Lonchocarpus* spp.).

State of Maranhão — Forbidding the felling of woods to make fuel-wood or charcoal in the Island of São Luiz.

State of Piauí — Constituting a forest regime and adopting dispositions to preserve, exploit and plant forest trees; prohibiting the felling of "carnaubeiras" (carnauba trees).

State of Ceará — Preventing the felling of trees along the roads and on the top of the mountains.

State of Pernambuco — Creating the State Forest Service and a "Horto Florestal."

State of Alagôas — Creating a Forest Service.

State of Sergipe — Issuing a Code governing the Forest Service.

State of Baía — Issuing instructions for the observance of the regulation covering the defense, preservation and utilization of the forests of the State.

State of Espirito Santo — Regulating a project for a State Forest Service.

State of Rio de Janeiro — Promulgating a Rural Code; creating Botanical Gardens; controlling the burning and felling of forests.

State of São Paulo — Installing a Botanical Garden; creating the Forest Service.

State of Paraná — Adopting numerous measures relative to the "herva mate," harvesting, preparation, packing, transportation, etc.; issuing a Forest Code for the State.

State of Santa Catarina — Summoning a Congress of Lumber Dealers and adopting practical and useful measures for the marketing of forest products and reforestation of depleted areas; controlling the harvesting of "herva mate," cutting, preparation, analyses, marketing and exportation of the product.

State of Rio Grande do Sul — Establishing a Forest Regulation and plans for the installation of a Forest Service.

State of Minas Gerais — Creating "Hortos Florestais."

Several States, such as Ceará, Pernambuco, Baía, São Paulo, Paraná, Santa Catarina, Rio Grande do Sul and Minas Gerais maintain up to the present date their forest services, under different regulations.

By virtue of decree no. 4.421, of December 28, 1921, the Brazilian Forest Service was created, regulated by decree no. 17,042, of September 16, 1925, and discontinued in 1933, due to alterations in the Ministries.

In 1934 there was approved the Forest Code, harmoniously incorporating all measures deemed necessary for the rational exploitation of Brazilian forests.

The Code comprises 9 chapters, a résumé of which is as follows:

I. *Preliminaries.* — Brazilian forests, as a whole, represent property of public interest to all inhabitants of the country, the property rights being exercised in accordance with the limitations established by the Code.

II. *Classification of the Forests.* — The forests are classified as follows:

(a) protected forests,
(b) forest reservations,
(c) model forests,
(d) profit-yielding forests

The *protected forests* are those which preserve the

water system; avoid erosion of the grounds through the action of natural agents; firm the sandy hills; assist in the defense of the frontiers, as deemed necessary by the military authorities; insure conditions for public health; protect the sites which by their natural beauty ought to be preserved; offer shelter for rare specimens of the indigenous fauna.

The *forest reservations* are those forming the national, state and municipal parks; those forests containing an abundance of rare specimens or where such specimens are cultivated, and those forests reserved by the Government authorities for small parks or woods for the recreation of the public.

The *model forests* are the artificial forests, formed by one or by a limited number of species, indigenous or exotic, the dissemination of which is deemed important in that region.

The *profit-yielding* forests are all those not included above.

The protected and reserved forests cannot be alienated.

The national parks, state and municipal owned, constitute natural monuments which perpetuate, in their floristic composition, certain parts of the country which for some special reason deserve to be perpetuated. Any action against the flora and fauna of the parks is forbidden.

III. *Exploitation of the forests.* — The following are forest products: stems, fuel-wood, roots, barks, leaves, flowers, resins, latex, *i.e.* anything that is taken from any plant.

Even the proprietors themselves are prohibited to set fires to fields in the neighborhood of arboreal vegetation to prepare grounds for farming or for the formation of agricultural land, without authorization from the local forest authorities and without exercising the necessary precautions, especially as to protecting groves, advice to the bordering neighbors, 24 hours in advance; to fell in already depleted regions, for the purpose of obtaining fuel-wood or charcoal, as well as in woods on the margins of rivers, lakes and roads of any description used for the welfare of the public; to gather the sap of trees which produce rubber, balata, gutta percha, chicle and other similar products or undertake the exploitation of tanniferous or fibrous plants, using methods which might jeopardize the life or natural development of the respective trees; to prepare charcoal or make fires within the forests, without the necessary precautions to avoid fires; to use for fuel or charcoal plants considered of great economic value for other more useful purposes; to fell trees in which are sheltered specimens of epiphytic plants or wild bee-hives, etc.

The river navigation companies and the railways using wood as fuel in their vessels or locomotives are obliged to maintain a reforestation service.

IV. *Forest police.* — The measures adopted for the policing and preservation of the forests are carried out all over the national territory by police representatives, guards or watchmen, nominated or designated especially for that purpose.

The guarding of the national parks and the preservation and maintenance of the protected and reserved forests fall within the jurisdiction of the Federal Forestry Department; however, the states and municipal districts may organize their respective forest services.

All employees of the forest service in the exercise of their duties are considered as public security agents and as such are allowed to carry arms.

In case of fire, the forest employee's duty is to requisite the available material means for extinguishing the fire and summon all men who are able to assist him.

V. *Infractions of forest regulations.* — Any actions or omissions contrary to the dispositions of the Code are considered as infractions.

When the infraction results from the fact that forest products or by-products are taken away, such materials will be seized and a penalty imposed on the infractor.

As regards forest offenses, the following are considered as such: to set fire to public-owned forests, to damage national state or municipal parks and protected and reserved forests; introduction of insects or plant diseases, the dissemination of which will be injurious to the economic value of the forests and will jeopardize their intended purposes.

The following are also considered as infractions: to penetrate without previous license into forests which are subject to a special regime; let loose animals, kill, hurt or mutilate in anyway ornamental plants; take away from public-owned forests, without previous authorization, stones, sand, lime or any mineral; make bonfires in the neighborhood of forests without the necessary caution.

VI. *The handling of infractions.* — The forest offenses are dealt with in a manner similar to that applied to ordinary crimes — the forest guard or watchman or any other authority issues a document covering the criminal act which should be signed by two witnesses and go through all other legal formalities.

VII. *Forest funds.* — This fund is derived from the following resources: contributions from enterprises, companies, societies, institutions, donations and amounts resulting from budget appropriations.

VIII. *Forest Council.* — The Federal Forest Council, with headquarters in Rio de Janeiro, will be constituted by the representatives of the National Museum, Botanical Garden, University of Rio de Janeiro, Service of Promotion of Vegetal Production, Touring Club of Brazil, National Highways Department, Municipal Forest Service and by other persons, up to 4, of acknowledged ability, nominated by the President of the Republic.

The Councils of the various States are constituted by representatives of institutions similar to the ones indicated above.

The Council, presided over by one of its members, elected by a majority of votes, meets at least twice a month.

The Council's duties are as follows: to promote and give earnest heed to the strict observance of the dispositions of the Code; to solve cases of negligence, propose amendments and alterations; to issue opinions relative to important questions; diffuse forest education, institute prizes for the encouragement of silviculture; promote the "Arbor Day," and organize silvicultural congresses.

IX. *General dispositions.* — Whenever deemed convenient, the government will issue adequate regulations to cover measures adopted for the defense of the forests.

*Present Situation of the Forest Problem.* — At present, various States and the Central Government of Brazil take care of their forests by means of specialized services.

Among the States, the more prominent services are those of the States of Ceará, Pernambuco, Baía, Rio de Janeiro, São Paulo, Rio Grande do Sul, and Minas Gerais.

The Central Government maintains a service identical to that of the states; however, the lack of technicians and professional foresters capable of directing such services has greatly delayed the solution of the forest problem in Brazil.

As an exception to the above, it must be mentioned that the State of São Paulo maintains the best service, not only public but also private.

Various railways of the country give the utmost attention and care to the reforestation of their lands and the "Companhia Paulista de Estradas de Ferro" is, without doubt, an example worthy of being known and imitated.

Dr. NAVARRO DE ANDRADE, Chief of the Forest Service of said Railroad, was the highest exponent of Brazilian silviculture, having contributed during his life to the planting of many million eucalyptus trees (*Cf.* CHRON. 7: 142).

The forest service of Brazil, in general, conducts small nurseries for the production and distribution of seedlings of forest plants to the agriculturists; studies of the flora and timber and the organization of national parks created by the eminent President of the Republic Dr. GETULIO VARGAS. It so happens, however, that at the present time the organization of such parks is not yet having the practical and ra-

tional direction which characterizes the European and North American parks.

SERVIÇO FLORESTAL,
RIO DE JANEIRO.

W. H. HODGE: **The Plant Resources of Peru:** — From pre-Incaic days to the present time plant products have always been the most important of the natural resources of Peru. The ancient Andean civilizations were the first to utilize several of the important economic plant contributions of the New World among them being the *potato, tomato, coca* (*Erythroxylon coca*), *cascarilla* (*Cinchona* spp.), *oca* (*Oxalis tuberosa*), and *quinoa* (*Chenopodium quinoa*). Although situated close to the equator, the cool climate of the mountains has made it possible for Peruvians to cultivate a wide range of temperate species in addition to those species of the tropics and subtropics cultivated in the lowlands.

The cultivation of vegetable products of Peru, like the formations of the natural vegetation, are variedly distributed throughout the three main physiographic zones[1]: 1. *La Costa*, 2. *La Sierra*, and 3. *La Montaña*. Because of the difficulty and expense of transportation across the Andes, large scale agricultural production is still practiced mainly on the coast.

*Plant resources of La Costa.* — The narrow coastal belt is the most important of Peru's agricultural zones for although the coast is largely a region of deserts it is dissected by innumerable small rivers whose waters serve to irrigate artificially the intensively cultivated soil contained in their valleys[2]. The accessibility of these valleys to the sea has facilitated transportation and commerce, the result being that the region of the coast contains the major portion of the Peruvian population.

The main crop plant of the coast is *cotton*, the principal export commodity of Peru. The whole life and national economy of the country is influenced by the volume of the crop and the trend of prices. There are 42 cotton-producing valleys scattered along the coast except for that sector lying between Huacho and Chiclayo. At least one species of cotton is indigenous to Peru and has been grown since the pre-Inca period. However, 85 percent of Peru's total cotton production comes from a high quality, disease-resistant variety called Tangüis, developed in Peru in 1912 from Smooth or Egyptian cotton. Tangüis is the whitest of the world's cotton varieties. The only other important variety is Pima cotton, grown in steadily increasing quantities chiefly in the Piura area.

In 1942 the number of hectares in cotton were 152,537, producing 1,450,000 quintales of which 225,000 quintales were consumed by the eleven local textile mills. 731,434 quintales were exported. In the same year Peruvian mills crushed 2,270,303 quintales of cottonseed, to yield 390,000 quintales of crude cottonseed oil and byproducts. Before World War II the bulk of the cotton crop was exported to Great Britain and Germany; the war practically eliminated the European market and brought increased purchases from the United States and Latin America.

In spite of a steady demand for Peruvian cotton, the acreage planted to this crop has been gradually reduced in the last few years. Growers have been unable to solve two main problems: shortage of fertilizer and increasing inroads of cotton pests and diseases.

*Sugarcane*, the second most important agricultural crop of Peru, is cultivated, under very favorable conditions of climate and soils, on the coast principally in the Chicama, Lambayeque, and Santa Catalina Valleys, where there are a number of large estates devoted to its culture. About 53,000 hectares are planted to cane and the yields per hectare — often 18½ tons of sugar per hectare — are very high. Unlike cotton which is a seasonal crop, sugarcane is a year-round crop which produced 480,000 metric tons of sugar in 1941-42. Sugar accounts for about 10 percent of Peru's exports.

*Rice* is grown to some extent on the coast particularly in the Lambayeque Valley, Pacasmayo, and Piura. The annual production is about 100,000 tons.

A number of miscellaneous products are grown along the coast. *Flax* is planted to a small extent in the valley of Pativilca and Cañete. *Olives* are important in the valleys of Moquegua (1000 tons a year), Camaná, Victor, Ilo, and Azapa. *Castor beans* are cultivated in the department of Piura where are to be found also large stands of *ceibos* (*Ceiba* spp.) which could be used to develop a sizeable kapok industry.* The department of Ica is known for its vineyards which annually produce ten million litres of white and red wines as well as three million litres of *piscos*, or pure grape spirits. Truck gardens are important in the valleys close to Lima, and all along the coast may be found sizeable plantings of *maize, yuca* (*Manihot esculenta*), *bananas, plantains*, as well as fruits such as *figs, oranges, mangoes*, and *pineapples*.

*Plant resources of La Sierra.* — The Peruvian sierra embraces an extensive belt including cold deserts or semi-deserts, grasslands, and warmer inter-Andean valleys. The sierra is essentially a high, tree-less region with a temperate climate and a seasonal rainfall, and will support most economic species requiring such a combination of climatic conditions. Irrigation is needed with most crops, as in the valleys of the coast, in order to insure a constant and even water supply; and because of this need most sierra agriculture is limited to the numerous valleys paralleling the several Andean ranges.

Unlike the coastal centers of agriculture which have many a large estate, the highlands possess small, agricultural holdings owned and worked in many districts by the native sierra Indians of the Aymará and Quechua races. Before the conquest these peoples cultivated their native staple crops of *maize, quinoa, coca*, and *potatoes* — often on amazing series of terraces still to be seen in use in many a steep-walled Andean valley. Potatoes (and maize) have long since spread around the world and, through selection and breeding, now surpass the puny types grown in the Andean homeland. It is surprising that oca and quinoa have not had widespread usage for they might also be developed elsewhere into valuable sources of food.

To this quartet of native sierra food-plants has long since been added the more important

1 For a more detailed description of these zones see LLEWELYN WILLIAMS: *The Phytogeography of Peru*.

2 See plant formation #1 on WEBERBAUER's vegetational map of Peru.

* The pods of *tara* (*Caesalpinea tinctoria*), a wild shrub of the riverbanks and Andean foothills, are the richest of all known tannin sources. Exports of tara pods (1500 tons in 1941) have increased rapidly in recent years.

types of the Old World. *Wheat* and *barley* are now commonly grown upon the higher lands, generally without irrigation, up to an elevation of about 14,000 feet.

In the inter-montane river valleys of the Marañon, Mantaro, Apurimac, Urubamba, Paucartambo, and their principal tributaries is found a mild climate suitable to the production of *sugarcane*. Because of transport difficulties and smaller yield, cane producers of the sierra are unable to compete with coast producers and so convert practically all their sugar production into alcohol, *aguardiente*, or other industrial spirits. It is estimated that 3% of the cane grown in Peru is crushed in the sierra but the same region produces 25% of the total alcohol manufactured.

Certain of these valley areas also produce temperate and subtropical fruits such as *apples, peaches, plums, quinces, pears, oranges, tangerines, sweet lemons,* and *lemons;* wild *chirimoyas* are also common. Also grown to some extent are minor crops such as *aniseseed* and *pyrethrum.*

Wherever the terrain is suitable for growth, particularly in semixerophytic middle elevations, one commonly finds two fiber plants often planted in hedges — the naturalized *Agave americana* and a native species of *Fourcroya.* These two are much used by the natives of the sierra to make rope and twine.

*Plants resources of La Montaña.* — The Peruvian *montaña* includes all the eastern forested regions. For the most part this zone is very moist and is covered by evergreen forests which extend west from the tropical lowlands of the Amazon basin onto the eastern slopes of the Andean front ranges up to temperate elevations of about 3000 meters[8]. In northern Peru where the Andes are lower, bits of temperate montaña forests have crept across the mountains and are to be found as irregular patches on the Pacific slopes in the departments of Piura, Lambayeque, and Cajamarca.

For years the network of lowland rivers has served as the only means of transportation into the montaña. Products originating in the area and destined for coastal Peru have to be placed aboard ocean freighters at Iquitos. From that river port they have to move down the Amazon, through the Panama Canal, and then south to Peruvian ports. Transportation costs have thus made prohibitive the development of agricultural resources in the montaña on any large scale. At the present time several new highways connecting coastal and Amazonian Peru are now in operation, and others, now in construction, will further aid in the opening up of the montaña. Peru is also depending increasingly upon aviation to supplement her tenuous, trans-Andean, transport facilities.

Peru's forested areas have been divided into two zones: *a.* the *ceja de la montaña,* which includes those fringes of low-statured montaña forests bordering upon the cool sierra; and *b.* the lowland *montaña,* composed chiefly of tall, tropical, rain-forests.

In the mountainous ceja de la montaña grow two important medicinal plants, *cascarilla* (*Cinchona* spp.) — whose bark is the source of the antimalarials, quinine and totaquina — and the shrub, *coca* (*Erythroxylon coca*) — whose leaves, much chewed (with lime) as a narcotic by the Indians of the sierra, are the source of the drug, cocaine. The richest cascarilla bark is harvested from trees found in the valleys of the upper Tambopata and Inambari rivers in the department of Puno, but World War II has stimulated the collection of this forest product throughout the whole range of the genus, *Cinchona.* Moreover plantations of high-yielding strains, developed in Java, are being started in several areas of the Peruvian cinchona belt. Coca is cultivated by the sierra Indians on small *chacras* situated in the forested areas of the departments of Puno, Cuzco, Ayacucho, and Huánuco. The major part of the annual production of coca leaves is consumed locally but about 350 tons are exported annually. A number of other plants with reputed medicinal value, but as yet uninvestigated scientifically, grow in various parts of the montaña.

*Coffee* is cultivated on the upper margins of the montaña, principally in the Chanchamayo Valley of Central Peru but also at Monteseco, on the Pacific slopes, in the department of Cajamarca. Small quantities of high grade coffee beans are exported.

The lowland montaña areas undoubtedly hold a wealth of yet unexploited forest products of which the hardwood timber resources are probably most important. Lumber mills exist near Iquitos in the department of Loreto where mahogany, cedar, and balsa are the valued species exported. Small mills have also been located near the eastern termini of the roads running from Lima to Tingo María, the Chanchamayo Valley, and Satipo — all in Central Peru. Lumber cut in these areas is brought over the Andes by truck for consumption in Lima.

Wild *rubber* (*Hevea brasiliensis*) — also *chiclé* and *balatá* — is produced in small quantities in the departments of Loreto and Madre de Dios. Investigations are now in progress leading to the introduction of a plantation rubber program. With a new tire factory in operation in Lima, Peru hopes to be self-sufficient as regards this native product.

Rotenone-bearing *cube* root (*Lonchocarpus* spp.) — also called *barbasco* —, with important insecticidal properties, is a montaña product with increasing economic importance especially in the export trade. Plantations of cube have been started to supplement the wild product gathered by the lowland Indians.

Wherever forest land has been cleared a number of types of tropical crops are cultivated. *Cacao* is produced in the departments of Loreto, Amazonas, and Cuzco; *tobacco,* a state monopoly, is grown in Tumbes, San Martin and Loreto; new *tea* plantations have been started near Tingo María; tropical fruits such as *avocados, papayas, oranges,* and *bananas* are important orchard crops in Lima's "fruitbasket," situated in the Chanchamayo Valley; while *rice, sugarcane,* and *yuca* are found throughout many areas of the montaña.

Peru is taking the initial steps to develop the montaña. Her difficulty hinges not only on deficient transportation but also on the lack of population in her eastern departments. Districts have been selected for colonization along the montaña roads, and in these locations agricultural experiment stations and colonization centers are working hand-in-hand in order to guide new settlers in all phases of tropical agriculture. One of the most important of these Peruvian stations, located at Tingo María, has been established in coöperation with agencies of the Government of the United States. The most important projects under investigation at present deal with plantation development of

[8] See plant formations #10, 11, and 12 on WEBERBAUER's vegetational map of Peru.

rubber, tea, cinchona, cube, and tropical food plants. Peruvian personnel for this and other agricultural experiment stations located not only in the montaña but also throughout the whole country are trained at La Molina, the Government agricultural school in Lima.

As yet no forest or soil conservation program has been initiated in Peru. In fact the Government's Ministry of Agriculture still lacks a Forest Service. In a country whose timber resources are vast and unknown, this is a serious deficiency. One of the first important tasks should be a forest survey. Forest legislation and organization, when promoted, might well be patterned after that of the Mexican Forest Service.

Another need of Peruvian agriculture is greater diversification of crops to enable the country to be self-supporting at least as regards food plants. With more than sufficient acreage for growing essential crops, Peru yet has to import such basic commodities as rice and wheat. With better cultural practices and the introduction of modern farm equipment, particularly in the sierra, Peru could make long strides in this direction. A forward step was taken with the formation in 1943 of the Inter-American Coöperative Food Production Service, known as SCIPA, made up of a coöperating group of Peruvian and North American agricultural specialists. Prominent on the agenda of this organization are such projects as the increase and improvement of the production of food products; development of plans for crop adjustment; development of new acreage with agricultural colonization; soil conservation; further development of extension work; provision of loans and other means of assistance to small farmers and growers; studies and dissemination of information regarding benefits of diet; plans for the improvement of transportation, storage, and distribution of agricultural products.

EMBASSY OF THE U. S. A.,
LIMA, PERU.

TEODORO ROJAS y J. P. CARABIA: **Breve Reseña de la Vegetación Paraguaya:**—El territorio Paraguayo se halla al sur de la parte central de Sur América, teniendo al norte la región de Matto Grosso, colinas éstas que separan el llano del Amazona al norte y el llano Paraguay-Argentino al sur. Al oeste Paraguay limita con Bolivia, al sur con Brasil y al este con la parte costanera sudeste del Brasil; teniendo al sur a la Argentina como país fronterizo.

El Paraguay está formado en su mayor parte, por un llano bastante bajo, pudiéndose decir que casi todo el país está comprendido dentro de la extensa cuenca del Río Paraguay y sus tributarios. No obstante lo dicho, al este del Paraguay encontramos una interesante región montañosa formada por las sierras Amambay-Mbaracayú, sierras, que en su mayor parte no pasan de ser pequeñas colinas de 200-500 m. de altura, pero las cuales se elevan rapidamente al nordeste del país donde encontramos las mayores alturas de dicha sierra, destacándose entre éstas La Estrella de 690 m. de altura y Punta Porá de 660 m.

Los ríos que corren a través del país son bastante numerosos y entre ellos el más notable es el Río Paraguay, que corta el territorio paraguayo en todo su largo desde el norte al sur, terminando su recorrido al desembocar en el caudaloso Río Paraná. Al oeste hay un grupo de ríos que nacen en la misma base de los Andes y después de haber recorrido todo el llano del Chaco, desembocan en el Río Paraguay. Al este encontramos otro grupo de ríos que partiendo de las sierras Amambay-Mbaracayú corren al oeste para desembocar también en el Río Paraguay.

La temperatura del Paraguay es bastante uniforme y se puede decir que no hay una gran diferencia entre las estaciones de verano e invierno, estaciones únicas que aquí se pueden distinguir. El promedio anual de temperatura es de unos 22° C., lo cual al sur es solo de unos 21° C. y al norte llega hasta 23° C. La temperatura máxima registrada es de unos 41° C., pero raramente se registran temperaturas de mas de 31° C. Las estaciones de verano e invierno están comprendidas entre los meses de Octubre a Marzo la primera y de Abril a Septiembre la segunda. Durante estas estaciones el mes mas caluroso es Enero, con un promedio de 27° C. y el mes mas frío es Junio, con un promedio de 14° C. La humedad atmosférica es bastante alta, registrándose de 40 a 90 grados de humedad, de lo cual las cifras mas altas corresponden al verano. Los vientos predominantes en el país son los del norte y sur, los primeros calurosos y fríos los segundos. El promedio de lluvias caídas durante un año, es de unos 2,200 mm., pero como es lógico esto se altera de acuerdo con las distintas regiones del país. En el Chaco el promedio de lluvias llega escasamente a 1,000 mm. anuales y en la región sudeste llega hasta 2,400 mm. anuales. Estas lluvias son distribuidas con bastante uniformidad durante las dos estaciones del año, pero en realidad el promedio mas alto corresponde al verano. En lo que respecta al Chaco ésto es muy variable y los períodos de seca a veces pasan de un año a otro, ocasionando que muchos ríos desaparezcan, apareciendo nuevamente con las torrenciales lluvias.

Al describir la vegetación del Paraguay, creemos será práctico dividirla en seis mayores asociaciones, entre las cuales la mas típica y extensa, es la de la región del Chaco, vegetación que pudiera considerarse como una comunidad independiente, pero sin embargo estamos mas inclinados a incluirla dentro de la asociación sabanas, pues mucho del Chaco consiste en extensos llanos cubiertos de gramíneas de alto porte y palmares mas o menos densos. En esta asociación se incluyen también las sabanas al este del Río Paraguay entre el Río Apa y Ypané, así como la parte central entre el Río Aguaray-Guazú y la ciudad de Asunción. La segunda asociación que haremos mención es la *halophytic* y la cual es muy frecuente en las cercanías de los arroyos y ríos que cortan todo el Paraguay, comunidad, que aparece también en la parte norte y extremo sur del país. Seguido mencionaremos la tercera asociación, representada por aquellas plantas que viven en las mismas márgenes de los ríos y lagunas, además de las que flotan en las propias aguas.

Las otras tres asociaciones que mencionaremos, serán aquellas propias de las regiones montañosas y entre las cuales primero describiremos la asociación de los montes húmedos tropicales, que se halla en la parte S.E. de este país, entre las sierras Amambay-Mbaracayú y el Río Paraná. La quinta asociación es el monte subtropical, vegetación que prácticamente cubre el resto de la sierra Amabay-Mbacarayú. Por último

mencionaremos la asociación *xerophytic*, la cual en realidad no ocupa una región determinada en el país y más bién corresponde a todas aquellas localidades donde encontramos terrenos quebrados y de rocas expuestas, como sucede alrededor de la ciudad de Asunción, en las faldas de las lomas del extremo norte del país y en muchas partes del Chaco.

La asociación del Chaco y demás sabanas del país están cubiertas de *Gramineae* y *Cyperaceae* entre las cuales se destacan las gramíneas de los géneros *Eragrostis, Leptochloa, Andropogon, Panicum, Paspalum* y *Guadua*. En las sabanas de la parte este del Río Paraguay encontramos un grupo de palmas que forman el dominante arbóreo de esa asociación y entre las cuales se destacan la *Acrocomia totai* y *Euterpe edulis* en los lugares mas áridos; siendo sustituidas por la *Geonoma Schottiana, Arecastrum Romanzoffianum* y *Bactris Anizitzii* en los lugares más húmedos. Al oeste del Río Paraguay y en la verdadera región del Chaco encontramos otro grupo de palmas propias de esa sabanas y entre las cuales la mas típica y dominante es la *Copernicia australis*, que forma densos palmares a todo lo largo de dicho río. Muchas otras veces en las mismas márgenes de dicha corriente, la *Copernicia australis* forma palmares mas claros y se asocia a un grupo de árboles entre los cuales se destacan la *Tecoma argentea, T. ochracea, Schinopsis Balansae, S. Lorentzii* y *Cochlospermum tetraporum*. Mas al oeste en la misma región del Chaco la *Copernicia australis* es sustituida por otras palmas, como *Trithrinax biflabellata* y *Bactris Anizitzii*. Otras veces en el mismo Chaco encontramos pequeños montes formados por *Cochlospermum tretraporum, Ceiba purcheli* y *Prosopis Kuntzei*. En los lugares más áridos del Chaco la vegetación dominante está formada por grupos de pequeños arbustos del género *Cassia* y *Capparis* y en los lugares desérticos una vegetación xerophytic toma lugar y entre estas las *Cactaceae* predominan.

La asociación *halophytic*, que es bastante extensa, está formada en parte por muchos elementos propios de los lugares bajos de las sabanas, como *Tecoma argentea* y *Acacia farnesiana*, pero otros elementos mas propios de esa asociación son: *Schinopsis Balansae, Cercidium andicolum, Froelichia paraguayensis, Alternanthera polygonoides, Lycium Morongii* y *Cienfuegosia Hasslerana*. La asociación que sigue a la anterior, es aquella formada por plantas que viven en las mismas márgenes de los ríos y lagunas o flotando en las propias corrientes; entre las primeras se destacan gramíneas del género *Guadua, Cyperaceae* como el *Cyperus giganteus, Scirpus riparius* y *Pontederia cordata*; entre las segundas *Eichhornia crassipes, Utricularia inflata*, y la interesante *Victoria Cruziana*.

La vegetación que consideramos como el monte húmedo tropical, no es muy extensa, pero lo suficiente para poder enumerar un grupo de interesantes árboles como la *Cedrela fissilis, Endlicheria hirsuta, Cecropia adenopus, Ficus Monckii, Chlorophora tinctoria, Didymopanax morototoni, Calophyllum brasiliense, Roupala brasiliensis* y *Rapanea Balansae*. En los lugares mas sombreados y húmedos de estos montes, encontramos colonias de helechos arborescentes como *Alsophila atrovirens* y *Cyathea Hassleriana*, junto a éstos es frecuente encontrar el *Costus pilgeri* y *Philodendron selloum*. En los lugares mas abiertos se destaca la interesante *Cordyline dracaenoides*.

La asociación del monte subtropical se caracteriza con la presencia del *Ilex paraguariensis*, asociado con el cual encontramos el *Prosopis juliflora, Prunus sphaerocarpa, Myrciaria cauliflora, Campomanesia obversa, Tibouchina violacea, Leandra atropurpurea, Miconia pussilliflora* y *Eugenia pungens*.

La última asociación a mencionar es la *xerophytic*, representado por un grupo de *Cactaceae, Bromeliaceae* y otras plantas, entre las cuales se destacan *Echinocactus Schumannianus, Opuntia stenaentha, Cereus paraguayensis, Bromelia Balansae y Pseudo-Ananas macrodontes*. De esta asociación pasamos gradualmente a un monte claro y *semi-xerophytic*, donde el suelo está cubierto de *Bromeliaceae* y el árbol dominante es *Prosopis juliflora*. De esta misma forma pasamos de la asociación *xerophytic* a un tipo de sabana donde el elemento arbóreo es el *Cocos Romanzoffiana* y en el suelo junto a las gramíneas, *Croton argenteus* y la *Opuntia stenaentha* son frecuentes.

A continuación damos una interesante lista de plantas, recopilada por el Dr. TEODORO ROJAS y entre las cuales se mencionan aquellas familias y especies más frecuentes del Paraguay.

Las *Pteridofitas* asuenden a 239 especies y las Fanerógamas a 4.600 aproximadamente, las *Gramíneas* más de 400, las *Ciperáceas* 140, las *Palmeras* 30, las *Bromeliáceas* 40, y las *Orquídeas* 70, especies.

Los helechos generalmente habitan sitios sombríos y húmedos como la *Cyathea Hassleriana, Hemitelia setosa* y *Alsophila atrovirens*. Entre las epifitas hállase representados *Lycopodium mandiocanum, Vittaria lineata* y *Polypodium lepidopteris*. Entre los terrestres de sitios secos, *Notholaema Balansae* y *Selaginella convoluta*.

Las *Gramíneas* que habitan barranca de ríos y riachos son *Guadua Trinii, G. angustifolia* y *G. paraguayana*. En los bosques sombríos, *Merostachys Claussení, Chusquea ramosissima, Lasiacis ruscifolia, Olyra latifolia* y *Melica sarmentosa*. En campos húmedos, *Panicum rivulare, Paspalum arundinellum, Tridens brasiliensis, Eragrostis hypnoides, E. glomerata, E. spicata, Paspalidium paludivagum, Pennisetum nervosum, P. frutescens, Andropogon lateralis* y *Sorghastrum nutans*.

*Ciperáceas* de sitios húmedos, *Cyperus giganteus, Scirpus riparius*, y de los sitios secos, *Rhynchospora exaltata, Bulbostylis papillosa* y *B. Langsdorffiana*.

Las *Palmeras* de sitios cultivados y de poblaciones, *Acrocomia totai*; de campos y bosques, *Arecastrum Romanzoffianum, Euterpe edulis, Attalea guaranitica, Geonoma Schottiana, Butia Yatay* y *Butia Yatay* var. *paraguayensis*. En la zona anegadiza chaqueña *Copernicia australis, Bactris Anisitzii* y *Trithrinax biflabellata*.

Las *Bromeliáceas* de campo y bosque, *Pseudoananas macrodontes, Ananas ananasoides* y *Bromelia Balansae*; propias de serranias, *Deuterohnia Meziana, Pitcairnia paraguayensis* y *Lindmania Rojasii*; de bosques xerófitos del Chaco Paraguayo, *Deinacanthon Urbanianum, Bromelia Hieronymi* y *B. Serra*. Estas últimas producen excelentes fibras.

Las *Orquídeas* de sitios secos, *Cyrtopodium punctatum, Catasetum fimbriatum, Brassavola Perrinii, Oncidium Jonesianum*; de sitios sombríos y húmedos, *Zygopetalum Hasslerianum*, y *Bulbophyllum Rojasii, Oncidium pulvinatum* y *O. cornigerum*.

Las *Dioscoreáceas*, con 21 especies, habitan campos y orillas de bosques, las más frecuentes son: *Dioscorea guaranitica, D. discolor*, cultivada por los indígenas por sus tubérculos comestibles.

Las *Leguminosas*, con 400 especies, constituye la familia más numerosa de las Fanerógamas del Paraguay. Están representadas por las especies siguientes: *Piptadenia macrocarpa*, corteza tanifera, *Enterolobium guaraniticum, Holocalyx Balansae, Pterogyne nitens, Ferreirea spectabilis, Enterolobium contortisiliquum, Peltophorum dubium. Copaifera Langsdorfii, C. Chodatiana, Lonchocarpus Muellbergianus* y *L. albiflorus*. Todas

forestales de importancia: *Caesalpinia melanocarpa, Prosopis Kuntzei, P. Fiebrigii, P. Hassleri* y *P. campestris*, igualmente forestales de importancia que habitan regiones del Chaco Paraguayo.

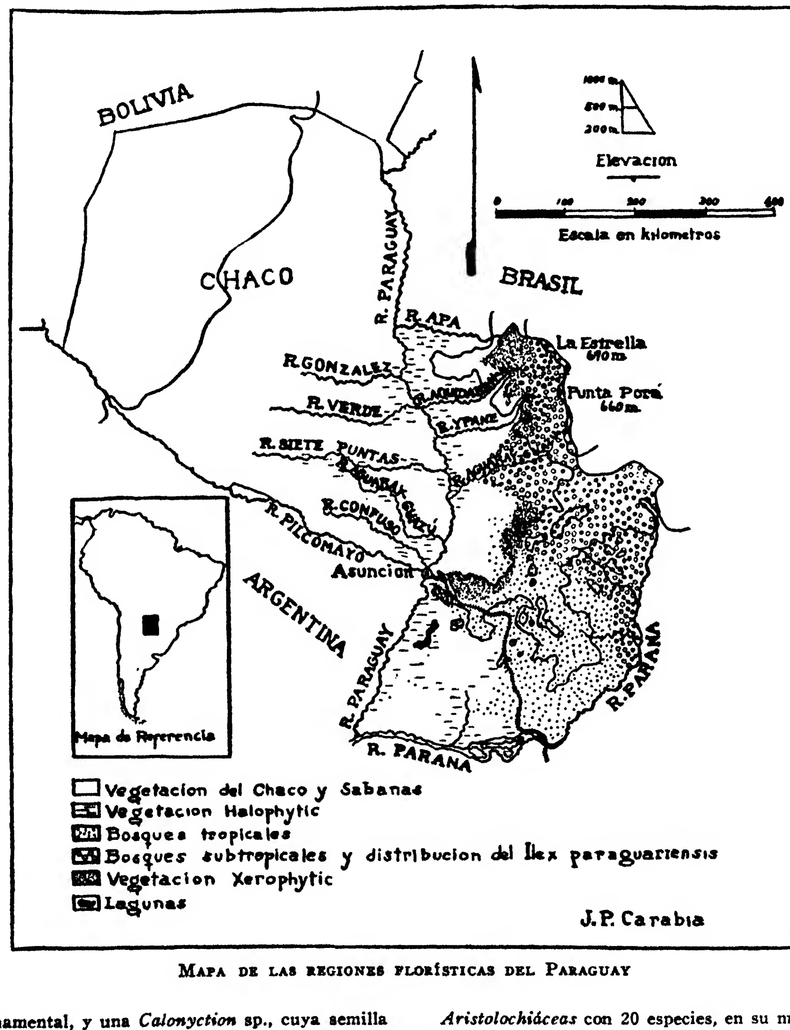
Las *Compuestas* más de 400 especies, otra familia con numerosos representantes interesantes, tales como *Moquinia polymorpha*, medicinal, *Stevia Rebaudiana*, edulcorante, *Eupatorium laeve*, colorante, *Eupatorium odoratum* y *Eupatorium oblongifolium*, de perfume.

Las *Rubiáceas*, con 110 especies: *Coutarea hexandra*, sustituto de la Quina; *Borreria Poaya* y *B. verticillata*, sustituto de la *Ipecacuana; Calycophyllum multiflorum*, forestal, *Genipa americana*, frutal, y *Relbunium hirtum*, tintorea.

Las *Convolvuláceas* con 115 especies: *Ipomoea bonariensis*, medicinal, *I. bonanox, I. acuminata*, y *Morremia ramosissima, Pavonia sepium, Sida rhombifolia* y *Wissadula subpeltata*, todas textiles, *Abutilon striatum*, planta ornamental.

Las *Moráceas* con 20 especies: los diferentes *Ficus*, habitan los bosques y sus orillas húmedas, como *F. Guapoi, F. Morongii, F. Monckii, F. anthelmintica, F. Rojasii, F. oximia*, de maderas livianas, además, *Brosium Gaudichaudii* y *Pseudomedia guaranitica*. Las especies de *Dorstenia* y *Cecropia* son medicinales, *Pseudo-Maclura brasiliensis* y *Chlorophora tinctoria*, esta última es de madera dura y colorante, *Soracea ilicifolia* y *S. saxicola*, zona boscosa y litoral.

Las *Meliáceas* con 40 especies: habitan generalmente las selvas, *Cedrela fissilis, C. Balansae, C. hirsuta, Cabralea Rojasii, C. oblongifolia, Trichilia cathartica*, y *Trichilia triphyllaria*, todos forestales de primer orden.




MAPA DE LAS REGIONES FLORÍSTICAS DEL PARAGUAY

*dissecta*, ornamental, y una *Calonyction* sp., cuya semilla es saponífera.

Las *Euforbiáceas*, con 150 especies, habitan campos, llanuras y bosques: *Alchornea triplinervia, A. iricurana* y *Croton urucurana*, producen maderas livianas *Manihot utilissima* y sus variedades, producen raíces comestibles, constituyendo uno de los principales alimentos del pueblo y una de las plantas económicas de más importancia; *Julocroton solanaceus*, raíces aromáticas, *Jatropha Isabelli*, raíces medicinales, *Phyllanthus Sellowianus* y *Ph. lathyroides*, la primera usada contra diabetes y la segunda como disolvente de cálculos renales. *Aporosella Hassleriana*, árbol de la barranca del río Paraguay.

Las *Malváceas* con 151 especies, habitan los campos y orillas de bosques: *Bastardiopsis densiflora*, forestal de madera liviana, sirve para celulosa de papel: *Abutilon*

*Aristolochiáceas* con 20 especies, en su mayoría plantas volubles de habitat del campo y orillas de bosques: *Aristolochia elegans. A. triangularis* de uso medicinal. *Aristolochia angustifolia* y *Euglypha Rojasiana*, habitan el Chaco Paraguayo.

*Ramnáceas* con 10 especies, habitan los bosques y sus orillas húmedas: *Rhamnidium Hasslerianum, R. elaeocarpum*, de maderas duras, y la *Colubrina rufa* y *Cormonema spinosum*, son nuevas especies para el país. *Zizyphus guaranitica* y *Z. oblongifolia*, habitan regiones del Chaco Paraguayo, frutos comestibles, vulgarmente conocido bajo el nombre de "Mistol."

*Capparidáceas* con 21 especies, todas habitan el Chaco Paraguayo, como *Capparis salicifolia*, fruto muy venenoso. *Capparis speciosa* var. *pruinosa*, frutos comesti-

bles, además *C. retusa, C. Tweediana* y *Crataeva Tapia*, esta última habita bordes del rio Paraguay.

*Hippocrateáceas* con 11 especies, casi todos arbustos y lianas de los campos y bosques: *Salacia campestris* y *S. crassifolia*, frutos comestibles.

*Sapindáceas* con 43 especies; lianas, arbustos y árboles, habitan campos y orillas de bosques: *Melicocca lepidopetala*. *Talisia esculenta*, frutos comestibles, *Sapindus saponaria*, *Paullinia pinnata* y *P. elegans* usado por los indígenas como barbasco. De uso medicinal, *Allophilus edulis*, *Cupania vernalis* y *Diatenopterix sorbifolia*, forestales.

*Loganiáceas* con 24 especies: *Strychnos brasiliensis* y *St. pseudoquina*, árboles cuyas cortezas se usan como antimalárica. Habitan las islas de los bosques del Norte del país. *Buddleia brasiliensis*, raices perfumadas y medicinal.

*Lauráceas* con 15 especies, habitan en el bosque como en el campo, todos arbustos y árboles: *Ocotea suaveoles*, *O. puberula*, *Nectandra membranacea*, *N. lanceolata*, producen maderas livianas; *Endlicheria hirsuta*, habita selvas húmedas de la Sierra de Amambay. Arbustos únicamente, *Ocotea Confusa*, y *Ayuea Hassleri*.

*Umbeliferáceas* con 41 especies, plantas de campos altos y húmedos, como *Eryngium Balansae*, y *E. eburneum*, *Hydrocotyle leucocephala*, medicinal.

*Cucurbitáceas* con 30 especies interesantes, todas volubles, muchas de frutos comestibles; la *Ceratosanthes Hilariana*, tiene tubérculo grande, cuyas aguas de vegetación sirve para apagar la sed en el Chaco Paraguayo, como medicinal, *Cayaponia podantha*, y *C. citrullifolia*, medicinal depurativa.

*Anacardiáceas* con 21 especies, *Schinopsis Balansae* y *Sch. Lorentzii* cuyas maderas producen el tanino, sirviendo también para construcción; *Astronium urundeuva* y *A. fraxinifolium*, solamente para este último fin; *Tapirira guyanensis*, producen maderas livianas propio para envases. Las cuatro primeras habitan el Chaco Paraguayo y la última la Sierra de Amambay. *Schinus therebinthifolius* y *Lithraea molleoides*, medicinales.

*Sterculiáceas* con 47 especies, *Sterculia striata*, frutos con semillas oleiferas comestibles, citamos *Helicteres guazumifolia* y *Buttneria catalpifolia*, como especies interesantes.

*Apocynáceas*, con 55 especies, todos arbustos, árboles y lianas, muchas especies de *Aspidosperma*, como la *A. polyneuron*, *A. Quebracho blanco*, *A. Quirandy* y *A. australe*, aparte de proporcionar maderas de construcción sus cortezas son medicinales. La *Hancornia speciosa*, produce un buen caucho y sus frutos son comestibles. Citamos como ornamental, *Thevetia bicornuta*, *Macrosiphonia longiflora*, *Dipladenia spigeliaflora* y *D. angustifolia*.

*Melastomatáceas* con 50 especies, habitan campos y bosques. Como plantas ornamentales recomendables: *Tibouchina herbacea*, *T. violacea*, *T. stenocarpa*, *Leandra atropurpurea*, *L. cremata*, *Miconia pussilliflora* y *M. theazans*.

*Rutáceas* con 17 especies, todos arbustos y árboles: *Balfourodendron Riedelianum*, recomendado para la reproducción forestal. *Fagara chiloperone*, *F. hiemalis*, *F. Riedeliana* y *Helietta longifoliata*, también forestales. Como medicinal: *Pilocarpus pennatifolius* var. *Selloana*.

*Borragináceas* con 50 especies: *Cordia longipeda*, *C. hypoleuca*, *C. Chamissoniana* y *C. Hassleriana* producen maderas excelentes para muebles. *Patagonula americana* cuya madera se presta para fabricar sillas como las de Viena, habitan selvas y campos.

*Bignoniáceas* con 71 especies, todas arbustos, árboles y lianas: *Tabebuia Ipe*, y *T. integra* producen maderas de construcción. *Jacaranda semiserrata*, *J. cuspidifolia*, y *Tecoma argentea*, cuyas cortezas son medicinales. Como ornamental: *Jacaranda cuspidifolia*, *Stenolobium stans*, *Bignonia unguis-cati*, *Melloa populifolia*, *Arabidaea rhodantha*, *Chodanthus splendens*, *Cuspidaria pterocarpa* y *Pyrostegia venusta*.

*Labiadas* con 76 especies, todas herbáceas y sufrútices, habitan los campos y llanuras. Las especies de *Ocimum Balansae*, *O. Selloi*, *O. neurophyllum*, *Salvia globiflora* se usan en la medicina. Como ornamental, *Salvia ambigens*.

*Zygophyllaceae*, La principal especie de esta familia, *Bulnesia Sarmientii* de una madera durísima y resinosa, habita las regiones xerofitas del Chaco Paraguayo.

*Malpighiaceae*, con 52 especies, muchas lianas, arbustos y pocos árboles, habitan generalmente los campos é islas de montes, apreciadas por sus hermosas flores. *Banisteria metalicolor*, *B. Hassleriana*, *Peixotoa cordestipula* y *Byrsonima coccolobifolia*. Las Banisterias son today lianas, algunas de aplicación medicinal. Las demás especies son arbustos y árboles.

*Myrtaceae*, las Mirtáceas cuyas especies (200) abundan en los campos como en las selvas, algunas producen frutos exquisitos, como *Myrciaria cauliflora*, *M. jaboticaba*, *Psidium guayaba*, *Campomanecia xanthocarpa*, *C. obversa*, *Eugenia uniflora*, y *Britoa selloviana*, etc. Como ornamental: *Myrciaria cuspidata*, *M. baporeti*, *Eugenia pungens* y *Myrcia assumptionis*.

*Solanáceas*, alrededor de 80 especies, muchas herbáceas, lianas, arbustos y árboles como *Solanum verbascifolium*, *S. inaequale* y *S. citrifolium*. Habitan los campos, llanuras y bosques: *Solanum foetidum* sus hojas produce un colorante azul. *Solanum grandiflorum*, frutos perfumados comestibles. En cultivos como plantas de adorno: *Brunfelsia uniflora*, *Solanum Rantonetti* y *S. jasminifolium*. Como especie interesante *Solanum chacoensis*, con raíces tuberosas.

*Scrophulariáceas*, con 56 especies, habitan los campos húmedos. Como planta ornamental recomendables: *Angelonia integerrima*, *Gerardia genistaefolia* y *Escobedia scabrifolia*. Esta última tiene en sus raíces un colorante propio para pastas y para teñir tejidos.

*Verbenáceas* con 75 especies, habitan campos y orillas de bosques húmedos. Como planta ornamental recomendables: *Duquetia furfuracea*, *Xylopia brasiliensis*, y *X. grandiflora*.

*Combretáceas* con 8 especies, todas lianas y árboles: *Combretum secundum*, ornamental: *Combretum Hasslerianum*, *Terminalia Balansae* y *T. modesta*, producen maderas flexibles.

*Sapotáceas*, con 10 especies, todos arbustos y árboles: *Chrysophyllum lucumifolium*, *Ch. pumilum*, *Lucuna paraguariensis*, *Labatia fragrans*, *Pouteria Migonei*, son de frutos comestibles. *Chrysophyllum maytenoides*, produce madera flexible, *Labatia glomerata* y *Pouteria salicifolia* habitan selvas ribereñas del Alto Paraná y Alto Paraguay. *Bumelia obtusifolia* y sus variedades, habitan regiones boscosas del Chaco Paraguayo.

*Ebenáceas* con 3 especies: *Maba inconstans*, *Dyospiros Hassleri* y *D. hispida* var. *camporum* de frutos comestibles.

*Guttiferáceas*, con 10 especies: *Kielmeyera oblonga*, árbol campestre, *Rheedia brasiliensis* y *Rh. macrophylla*, frutos comestibles habitan las selvas de la región oriental, *Calophyllum brasiliense*, dá una madera liviana propia para envases, habita bosque húmedo, Sierra de Amambay.

*Tiliáceas*, con 10 especies, habitan campos y bosques. Los principales son *Luhea uniflora*, *L. paniculata*, *L. divaricata*, *L. speciosa* cuyas flores son melíferas. Las maderas de esta especie por su naturaleza son igualmente apreciada para tonelería. *Heliocarpus americanus* tiene la madera liviana y el liber de su corteza es fibrosá.

*Flacourtiáceas*, con 15 especies, todos arbustos y árboles que habitan bosques y litoral de los ríos: *Prockia glabra*, *P. Hassleri*, *Banara macrophylla*, *B. bernardinensis*, *Casearia Hassleri*, *C. gossypiosperma*, producen maderas de construcción. La *C. silvestris*, cuyas hojas utilizan contra las mordeduras de víboras.

Una sola especie de *Proteáceas*, se conoce del Paraguay: *Roupala brasiliensis*, árbol que habita los bosques de la región del Guairá y Alto Paraná, la madera es apreciada por su hermoso veteado.

*Bombacáceas*, con 12 especies, todos árboles, habitan campos y bosques ralos: *Bombax marginatum*, cuyas semillas están envueltos en una seda vegetal de color marrón, su corteza contiene fibra liberiana, *Chorisia insignis* y *Ch. speciosa*, producen seda vegetal blanca. *Ceiba Burchelli* habita los campos del Chaco Paraguayo y *Ceiba pubiflora* los montes de la Cordillera de Altos. Las semillas de todas estas especies contienen un aceite comestible.

*Aquifoliáceas*. Esta familia representada en el Paraguay por diversas especies, la principal *Ilex paraguariensis* y sus variedades que producen la Yerba mate o Té del Paraguay. Habita los campos y bosques húmedos de la región del Guairá, Alto Paraná y Alto Paraguay.

*Piperáceas,* cuenta alrededor de 50 especies, herbáceas y arbustos, algunas epífitas (*Peperomia*). Habitan bosques sombríos y húmedos: *Piper fulbescens, P. angustifolium, Peperomia cyclophylla* y *P. rotundifolia.*

*Lythraceae,* esta familia comprende 35 especies, todas herbáceas sufrutecentes y árboles, como *Lafoensia Pacari,* la madera de esta es resistentes en tierra, además produce un colorante amarillo.

*Lecythidáceas,* una sola especie conocida del Paraguay, *Cariniana excelsa,* árbol de dimensiones considerables, habita los bosques de la Sierra de Amambay, su madera es liviana propias para envases.

*Cactáceas,* conocidas del Paraguay alrededor de 60 especies, habitan las serranías de la parte oriental del país y las zonas xerófitas del Chaco Paraguayo, citamos: *Pereskia aculeata, Opuntia paraguayensis, Cereus paraguayensis, C. Koryne, C. Hassleri, C. Baumannii, Echinopsis rhodotricha, Echinocactus Hartmanii, E. Schumannianus, E. paraguayensis, E. Anizitzii, E. Mihanovichii* y *Harrisia Martinii.*

*Erythroxyláceas,* con 21 especies todos arbustos y arbolitos, habitan campos y bosques ralos tanto del lado oriental como del Chaco Paraguayo, citamos: *Erythroxylon microphyllum, E. Hasslerianum, E. cuneifolium, E. paraguariense* y *E. verruculosum.*

*Styracáceas,* representadas por siete especies, todas arbustos y árboles, los principales *Styrax leprosa, St. camporum, St. obliquinervia* y *St. ferrugineus,* habitan isla de bosque húmedo y campo.

*Myrsináceas,* con ocho especies todas árboles que habitan selvas y sus orillas, las más frecuentes: *Rapanea ferruginea, R. guyanensis, R. laetevices, R. Balansae* y *Clibanthus detergens,* esta última habita selvas húmedas de la Sierra de Amambay.

*Symplocáceas* con nueve especies todas árboles que habitan generalmente islas de bosques y campos, como *Symplocos celastrinea, S. lanceolata, S. uniflora* y *S. Klotzschii.*

*Vochysiáceas,* con ocho especies todas árboles típicos de campos e islas de bosques, las principales: *Vochysia tucanorum, Qualca Cordata, Q. parviflora, Q. grandiflora* y *Q. multiflora.*

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J. P. CARABIA: **Productos Naturales y Agricultura en el Paraguay:** — Ocupa el Paraguay una posición geográfica y política bastante desfavorable. Una de las desventajas del Paraguay, es el tener fronteras comunes con varias repúblicas hispano-americanas, lo cual ha originado innumerables y sucesivas guerras de origen fronterizo entre el mencionado país y esas repúblicas vecinas. Otra desventaja para el Paraguay, es el no tener salida directa al mar, lo cual impide grandemente el intercambio rápido de los productos naturales de ese país. El Paraguay es la república más pequeña de Sur América, con excepción del Uruguay. Su población, que es la más reducida de todo el continente sudamericano, alcanza sólo un promedio de unos dos habitantes por kilómetro cuadrado. Por las razones mencionadas y otras más, la agricultura e industria del país no han progresado como es de desearse.

Los numerosos ríos que atraviesan el Paraguay, constituyen los principales medios de transporte de este país, siendo de mencionarse en primer lugar el río Paraguay, que corre de norte a sur cortando el país a todo su largo. Otro río importante es el Paraná, que corre más o menos en la misma dirección que el anterior, pero a lo largo del extremo este del país. Estos dos ríos, son navegables en su mayor parte y embarcaciones de 10-12 pies de calado son frecuentes en esas corrientes. Los otros ríos que corren de este a oeste y en forma contraria, sirven de medio de transporte en las partes interiores del país. Las líneas ferroviarias no pasan de unos 500 kilómetros y éstos, en su mayor parte, corresponden al ferrocarril del extremo sur, que partiendo de Asunción pasa por Villarica para entrar en Argentina. Los caminos y carreteras para tráfico pesado son muy reducidos y de poca importancia.

El Paraguay tiene unos 458,000 kilómetros cuadrados, de los cuales una gran parte no pasan sobre los 300 m. de altura sobre el nivel del mar, por lo que terrenos bajos y anegadizos son bastante frecuentes. A pesar de lo dicho unas tres cuartas partes del territorio paraguayo es cultivable, pero, hasta la fecha, sólo el uno por ciento de éste se dedica a la agricultura, sin contar los extensos prados naturales del Chaco que se dedican a la ganadería.

En forma general, se puede decir que el Paraguay está dividido en dos grandes regiones naturales; una, al oeste del río Paraguay o sea la región del Chaco, y otra, al este de dicho río. La parte oeste o Chaco, es un extenso territorio que comprende las dos terceras partes del área total del país; en su mayor parte es arenoso, bajo y algo anegadizo. La vegetación del Chaco está formada principalmente por sabanas de gramíneas pertenecientes a los géneros *Panicum, Paspalum* y *Guadua.* Estas sabanas son también frecuentemente interrumpidas por manchas de montes, muy especialmente a lo largo de arroyos y ríos, alcanzando su mayor representación en las márgenes del río Paraguay, donde estos montes forman una franja continua a todo su largo. Al este del río Paraguay, encontramos los terrenos más propios para la agricultura; terrenos que al noreste son ondulados y algo arenosos, al centro también ondulados y muy fértiles, y, al sur, bajos y anegadizos pero propios para varios cultivos. A lo largo del extremo este del país, encontramos una extensa región montañosa, donde existen los montes más ricos del país.

Hay en el Paraguay aproximadamente un millón de habitantes, de los cuales la mayor parte residen en las partes sur y central del país, donde encontramos precisamente las mayores ciudades, tales como: Asunción (capital del Paraguay), Villarica, Itá, Capitatá, Encarnación, Caazapá, Concepción, además de otras de menor importancia. La mayor parte de la población está formada por descendientes de extranjeros, principalmente españoles, italianos, polacos y alemanes menos en la parte oeste o Chaco, cuya población está formada en su mayoría por indios guaraníes y mestizos de indios y españoles.

La principal industria del Paraguay es la ganadería, 1; a la cual le siguen en importancia varios cultivos y explotaciones forestales: entre estos ocupan el primer lugar, el cultivo del algodón, 2; explotación del quebracho, 3; otras

maderas de construcción, 4; yerba mate, 5; petit-grain, 6; tabaco, 7; azúcar, 8; arroz, 9; tung-oil, 10; además de estas explotaciones agrícolas, se cultivan para el consumo interior un grupo de vegetales, 11; tales como batata, mandioca, frijoles, maní y otros más.

1. *Ganadería.* — Desde épocas coloniales ha existido en el Paraguay la ganadería, habiendose podido desarrollar tan favorablemente gracias a los extensos prados naturales del Chaco. Desde su origen, la explotación ganadera del Paraguay, ha estado íntimamente ligada con la de la vecina República Argentina, razón por la cual, la industria ganadera del Paraguay sufre juntamente con la de Argentina los efectos de la guerra actual. Según estadísticas recientes, hay en el Paraguay unos 4,000,000 de bovinos, los cuales en su mayoría son criollos y algunos pocos resultado de cruza con ganado de raza. Además de lo dicho hay unos 13,000 ovinos y 112,500 equinos.

2. *Algodón.* — El cultivo del algodón, constituye la explotación agrícola más importante del Paraguay, lo que se debe sin duda a la buena calidad de su fibra y al mercado sudamericano fijo. Se cultivan con predilección variedades de *Gossypium barbadense* y *G. hirsutum.* La exportación anual de algodón se calcula alrededor de unos 10,000,000 de kilogramos, lo cual representa una alta cifra en la exportación total del país.

3. *Quebracho.* — Entre las distintas maderas que se explotan en el Paraguay, el quebracho ocupa el primer lugar. La importancia de esta madera se debe a su gran contenido de tanino, aunque también tiene gran valor como madera para traviesas de ferrocarril y construcción en general. Hay en el Paraguay varios árboles conocidos como quebracho, pero el más apreciado es el quebracho macho, *Schinopsis balansae,* al cual le sigue en importancia el quebracho colorado, *Schinopsis lorentzii.* Otro árbol confundido generalmente con el verdadero quebracho, es el quebracho blanco, *Aspidosperma quebracho-blanco* que se explota con los mismos fines que los otros quebrachos. El área natural de los quebrachos está constituído por la franja de monte a lo largo del río Paraguay y por las manchas de montes de la misma región del Chaco. La exportación de quebracho como madera, alcanza unas 25,000 toneladas métricas anuales y 60,000 toneladas métricas de tanino de las propias maderas.

4. *Maderas en general.* — Hay en el Paraguay un gran número de maderas valiosas, siendo las más explotadas: *Piptadenia communis, Astronium gracile, A. balansae, Banara bernardiensis, B. hassleri, Cedrela fissilis, Trichilla catigua* y *Prosopis juliflora,* todas las cuales son propias de los montes altos de la región este del país. Otras maderas valiosas, propias de la región del Chaco, son: *Bulnesia sarmientii, Tecoma* spp., *Tabebuia* spp. y *Jacaranda* spp.

5. *Yerba mate.* — La explotación de la yerba mate constituye una de las industrias más típicas e importantes del Paraguay. La yerba, *Ilex paraguariensis,* crece en Paraguay, Argentina y Brasil, pero es en el Paraguay donde esta planta abunda más, por la cual este país ha ocupado siempre el puesto de mayor importancia entre los productores de yerba mate. Los principales yerbales paraguayos se encuentran en la región montañosa oriental y también al sudeste de esta región, pero las recientes plantaciones han hecho que el área natural de las mismas se extienda más allá de los límites indicados. El Paraguay exporta unos 8,000,000 de kilogramos de yerba mate al año, que en su mayor parte son consumidos por Argentina, país donde la práctica del mate es muy popular.

6. *Petit-grain.* — Desde épocas coloniales, se han cultivado en el Paraguay un gran número de plantas cítricas, con el objeto de extraer de sus frutos jóvenes y de sus hojas, el aceite vegetal conocido con el nombre de petit-grain. Entre las principales variedades cultivadas, están aquellas conocidas como naranja agria, apepújha y apepú, todas las cuales son variedades de *Citrus aurantium.* La producción anual de petit-grain es muy variable, pero podría decirse que anualmente se exportan unos 150,000 kilos de este aceite.

7. *Tabaco.* — El cultivo del tabaco, *Nicotiana tabacum,* está tomando cada día más importancia, lo cual se debe a su calidad que es tan buena como la de los tabacos de Cuba, y por ser sudamérica un gran mercado para éste producto. Las regiones más propicias para el cultivo del tabaco, son las partes algo onduladas del centro y norte del país. Según estadísticas, la exportación del tabaco alcanza a unos 15,000,000 de libras anuales.

8. *Caña de azúcar.* — El cultivo de la caña de azúcar, *Saccharum officinarum,* es casi exclusivamente para el consumo interno, pero, no obstante, la exportación de alcoholes, mieles y otros derivados del azúcar, toma cada día más importancia en la lista de productos para la exportación.

9. *Arroz.* — El cultivo del arroz, *Oryza sativa,* está desarrollándose rápidamente, pero hasta la actualidad la producción no pasa de la requerida para el consumo interior. Los terrenos propios para el cultivo del arroz, son muy extensos en el Paraguay, razón por la cual es de esperarse que en el futuro este cultivo se intensifique más. Las principales plantaciones de arroz se encuentran en la parte sur del país, pero las hay también en la región central.

10. *Tung oil.* — Esta es otra de las plantas a las que en la actualidad se les está dando gran importancia, ya que su cultivo en este país parece ser muy halagador y por tratarse de un producto con gran mercado internacional. La especie más cultivada es: *Aleurites fordii,* pero también se cultiva, aunque en menor escala, *Aleurites montana.*

11. *Cultivos en general.* — Además de los cultivos mencionados, se cultivan también un gran número de plantas para el consumo interno, entre las cuales las más frecuentes son: batata, *Ipomoea batatas;* mandioca, *Manihot esculenta;* frijoles, *Phaseolus vulgaris;* maní, *Arachis hypogaea,* papas, *Solanum tuberosum;* malanga, *Colocasia antiquorum* y muchos otros vegetales y plantas de hortaliza.

El Paraguay cuenta con un gran número de industrias derivadas de las explotaciones ganaderas y agrícolas, muchas de ellas de gran importancia. Entre estas industrias se destacan la curtiembre de cueros y la conservación de carnes y grasas de origen animal. Otras industrias están relacionadas con el tejido y mejoramiento del algodón, mejoramiento de lanas, aceites vegetales (tales como: aceite de algodón, cítricos, de coco y tung oil); producción de alcoholes, mieles y otros derivados del azúcar. Sin duda, una de las industrias más importantes, es la explotación del tanino, que se obtiene de los quebrachos.

Existen en el Paraguay algunos minerales, tales como hierro, manganeso, cobre y otros

de menor importancia, pero ninguno de ellos en cantidades suficientes para adquirir valor comercial.

Las exportaciones del Paraguay alcanzan unos 15,000,000 de pesos oro* al año, correspondiendo de estas cifras el 23% a Argentina, 15% a Alemania, 12% a Inglaterra, 5% a los E. U. de N. A., 5% al Japón y el resto a otros países. En cuanto a las importaciones, estas suman unos 12,000,000 pesos oro anuales y proceden de Argentina 50%, del Japón 14%, de Alemania 12%, de los E. U. de N. A. 5%, de Inglaterra 4% y el resto, de varios otros países. Con la presente guerra, todas estas cifras han sido grandemente alteradas y la escala comercial ha mejorado notablemente entre el Paraguay y los E. U. de N. A.

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NEW YORK CITY.

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LORENZO R. PARODI: **Las Regiones Fitogeográficas Argentinas y sus Relaciones con la Industria Forestal:** — De los 2.949.300 kilómetros cuadrados de superficie que tiene la Argentina, aproximadamente la tercera parte está cubierta por formaciones boscosas que contienen especies maderables. Tres grandes regiones fitogeográficas carecen de árboles, por lo menos en sus condiciones naturales, o sus bosques son exíguos, mientras que las restantes, son regiones boscosas, pobladas por esencias arbóreas, muchas de ellas de alto valor económico.

El clima es cálido y lluvioso; las temperaturas medias anuales oscilan entre 20° y 21° C, pero las mínimas absolutas bajan hasta 0° C, impidiendo el crecimiento de especies megatérmicas como el caucho y el cacao. Las lluvias fluctuan entre 1500 mm en el sur y 1800 mm en el norte, distribuidas en unos 100 dias por año.

Carecen de árboles la *Estepa patagónica*, la *Estepa pampeana* y el *Desierto andino*; de ellas, la *Estepa patagónica* y el *Desierto andino* poseen escasas condiciones para los cultivos arbóreos, aunque ofrecen lugares reducidos, donde podrían efectuarse algunos cultivos sin carácter de industria. La *Región pampeana*, en cambio, aunque carece de árboles naturalmente, ofrece condiciones propicias para la forestación siempre que se elijan especies adecuadas y se les prodigue el cuidado necesario durante la primera edad.

Las regiones fitogeográficas argentinas son las siguientes, que designamos conforme al tipo de vegetación que cubre el territorio, adoptando, en los casos posibles, la nomenclatura de TANSLEY and CHIPP (1926): —

1. **Selva misionera (Rain forest).**
2. **Selva de montañas subtropicales Tucumano-boliviana (Mountain forest).**
3. **Parque Chaqueño (Transition from Closed forest to Parkland).**
4. **Bosque Pampeano (Open woodland).**
5. **Parque mesopotámico (Marginal forest and Parkland).**
6. **Bosques subantárcticos.**
7. **Estepa pampeana (Grassland = Llanura bonaerense).**
8. **Monte occidental (Matorral xerófilo).**
9. **Estepa patagónica (Semidesierto patagónico).**
10. **Desierto andino (Estepa desértica de altiplano).**

1. *SELVA MISIONERA.* — Cubre algo más de las ⅘ partes del Territorio de Misiones, que se halla en el noreste argentino, entre los ríos Paraná y Uruguay. Al oeste limita con el Parque Mesopotámico por una zona de transición que baja entre Santa Ana y San Ignacio, sobre el Paraná y llega algo más al este de Concepción sobre el Uruguay. Es la selva de los estados brasileños de Paraná y Santa Catalina y del este del Paraguay que penetra en territorio argentino. Es una foresta cerrada, de tipo tropical, caracterizada por tener corpulentos árboles que suelen alcanzar 40 m de altura, cubiertos de lianas y epífitas y entremezclados con arbustos, bambuseas y plantas herbáceas, formando una maraña compacta muy difícil de penetrar.

Las especies arbóreas, como ocure ordinariamente en las regiones tropicales, no forman consociaciones puras, sino que están dispersas y entremezclada con otras, siendo ordinariamente escasa su proporción por hectárea. Por ello la explotación de las especies útiles es difícil y debe efectuarse a costa de gran trabajo, practicando picadas hasta llegar a donde están los grandes árboles hachados en la selva y poder extraerlos. No obstante que en cada localidad suelen agotarse las especies más valiosas la selva parece quedar intacta debido a la escasa proporción en que aquéllas se presentan por hectárea. En esta selva, una de las pocas especies arbóreas de grandes dimensiones que se presenta con carácter predominante, aunque en superficie poco extensa, es *Araucaria angustifolia*, cuya área forma una cuña que penetra por el noreste del territorio y termina en punta, cerca de Fracrán, en el centro del mismo. También la yerba mate (*Ilex paraguariensis*) suele abundar en algunos lugares pero su intensa explotación la ha reducido notablemente.

Entre las especies forestales más valiosas citaremos: el lapacho (*Tecoma ipe*), el cedro (*Cedrela fissilis*, var. *macrocarpa*), el guayaibí (*Patagonula americana*), el urunday (*Astronium balansae*), el timbó (*Enterolobium contortisiliquum*), el ibirá-peré (*Apuleia leiocarpa*), el viraró (*Pterogyne nitens*), el pino (*Araucaria angustifolia*), etc.

2. *SELVA TUCUMANO-BOLIVIANA.* — Es una selva majestuosa, con árboles de 30 a 35 m de altura, que se extiende en estrecha faja sinuosa por las faldas orientales de los contrafuertes andinos, entre 450 y 2500 m s.m. alcanzando hasta el grado 28° (Lat. S.) en la provincia de Catamarca. Es rica en especies tropicales y subtropicales; su anchura es de unos 80 Km en la región oranense, empobreciéndose y estrechándose a medida que avanza hacia el sur. Está limitada en el piso inferior por la zona chaqueña occidental (Región del cebil) y en el piso superior por la Estepa graminosa andina que, según los lugares, cubre las pendientes inclinadas entre los 2000 y 3000 m s.m.

Debe su origen a las altas temperaturas medias anuales y a la humedad traída por los vientos que soplan del este y vienen a condensarse en estas laderas produciendo abundantes lluvias. Aunque los registros pluviométricos en dichos lugares son escasísimos, se calcula entre 1000 y 1700 mm la precipitación anual. Las altas temperaturas que se producen favorecen una intensa

* El "peso oro" (moneda oficial del Paraguay) equivale aproximadamente a unos 0.60 o 0.70 de dólar.

evaporación que contribuye notablemente a mantener la abundante humedad que da origen a tan exuberante vegetación higrófila.

En el piso inferior, donde el clima es más cálido es donde crecen los árboles más altos y donde la selva es más tupida.

Entre los árboles más característicos hallamos el laurel (*Phoebe porphiria*) árbol de gran corpulencia, la tipa (*Tipuana tipu*) también gigantesca, alcanzando en ciertos lugares hasta 40 m de altura y un metro y medio de diámetro, el cedro (*Cedrela lilloi*), el nogal (*Juglans australis*), el lapacho rosado (*Tecoma avellanedae*), el cebil (*Piptadenia macrocarpa*), el roble argentino (*Torresea cearensis*), el canelón (*Rapanea laetevirens*), la higuerilla (*Carica quercifolia*), el ceibo (*Erythrina falcata*), los lecherones (*Sapium* sp.), el palo blanco (*Calycophyllum multiflorum*), el carnaval (*Cassia carnaval*), el naranjillo (*Fagara naranjillo*), varias especies de *Coccoloba*, etc. Más al norte, en Jujuy y Salta, la flora es más rica creciendo además otras especies megatérmicas como la chunta (*Acrocomia chunta*), un *Ficus* no determinado aún, una Bambusea del género *Arthrostylidium*, etc.

Más arriba, generalmente después de los 1200m, según la latitud, se extiende la asociación del aliso (*Alnus jorullensis*, v. *spachii*) formando consociaciones casi puras en unos casos y en otros asociado con el sauco (*Sambucus peruvianus*) y diversas de las especies antes citadas; otra especie que se le asocia, o crece formando bosques muy puros, es el pino (*Podocarpus parlatorei*) que también habita a 1700-1900 m s.m. Ambas especies (pino y aliso) son estimadas por el valor de sus maderas por lo que su explotación suele ser despiadada; ambos son árboles corpulentos que suelen sobrepasar los 30 m de altura.

3. *PARQUE CHAQUEÑO.* — Se extiende al oeste de los ríos Paraguay y Paraná hasta confundirse con la selva Tucumano-boliviana al pie de los contrafuertes andinos más orientales; en el norte comienza en los territorios de Bolivia y el Paraguay y baja hasta las sierras de Córdoba y la zona media de la provincia de Santa Fé. En la Argentina se extiende entre los paralelos 22° y 31° lat. S. y su flora es muy rica por poseer numerosas especies propias, y por recibir elementos de las regiones colindantes. La vegetación es muy heterogénea; está compuesta por bosques de diferente aspecto, y selvas en galería, que alternan con savanas de altas gramíneas y pajonales subanegados. Comprende: A, Una zona oriental, más húmeda, con suelos a veces bajos y anegados donde crecen numerosas especies de Paniceas; habitan en ella, ademas de las especies arbóreas que componen sus bosques dos especies forestales valiosas que no existen en el oeste; ellas son el quebracho santafesino (*Schinopsis balansae*) explotado para extraer tanino, y el lapacho (*Tecoma ipe*); en las islas de los rios Paraguay y Paraná crece la picanilla (*Guadua paraguayana*) muy explotada por el valor y aplicaciones de sus cañas macizas. — B, Una amplia zona intermedia más seca, con suelos llanos donde alternan bosques y savanas; en ella crecen muchas especies de *Prosopis* (*P. alba, P. nigra, P. ruscifolia, P. kuntzei*, etc.), el quebracho santiagueño (*Schinopsis lorentzii*), muy codiciado por las multiples aplicaciones de su madera durísima, el guayacan (*Caesalpinia melanocarpa*), el mistol (*Zisiphus mistol*), el palo santo (*Bulnesia sarmienti*), las palmas (*Trithrinax campestris* y *T. biflabellata*), el quebracho blanco (*Aspidosperma quebracho*), etc. — C, Cerca de los contrafuertes andinos existe la zona que LILLO (1919) designó Formación del cebil y que representa un bosque de transición entre el Parque chaqueño y la selva Tucumano-boliviana; posee especies comunes a ambas formaciones, pero su aspecto de bosque abierto, con abundante cesped graminoso, lo hace confundir con el Chaco. — D, Al oeste del río Dulce, en el suroeste de Santiago del Estero, se extiende otra zona, que contiene el quebracho blanco y el santiagueño, y gran número de las especies de la zona B, mezclados con jarilla (*Larrea divaricata*) como especie secundaria; en muchos lugares, por causa de la extrema explotación de los quebrachos y especies arbóreas, el bosque se presenta degradado y reducido a un matorral; esta comunidad termina en la sierra de Ambato por el oeste y por el sudeste on las sierras de Córdoba y San Luís. Son Bosques de Transición (PARODI, 1942), típicamente chaqueños, que empobreciéndose en las especies arbóreas, van a confundirse con el Monte occidental en el oeste.

Por su afinidad sociológica y por su aspecto, deben reunirse con el Chaco los bosques de la Pampa Central que trataré a continuación.

4. *BOSQUE PAMPEANO.* — Representa un distrito del Parque chaqueño que desde el centro norte de San Luís se extiende por la zona oriental de la Pampa Central hasta su límite austral con el río Colorado.

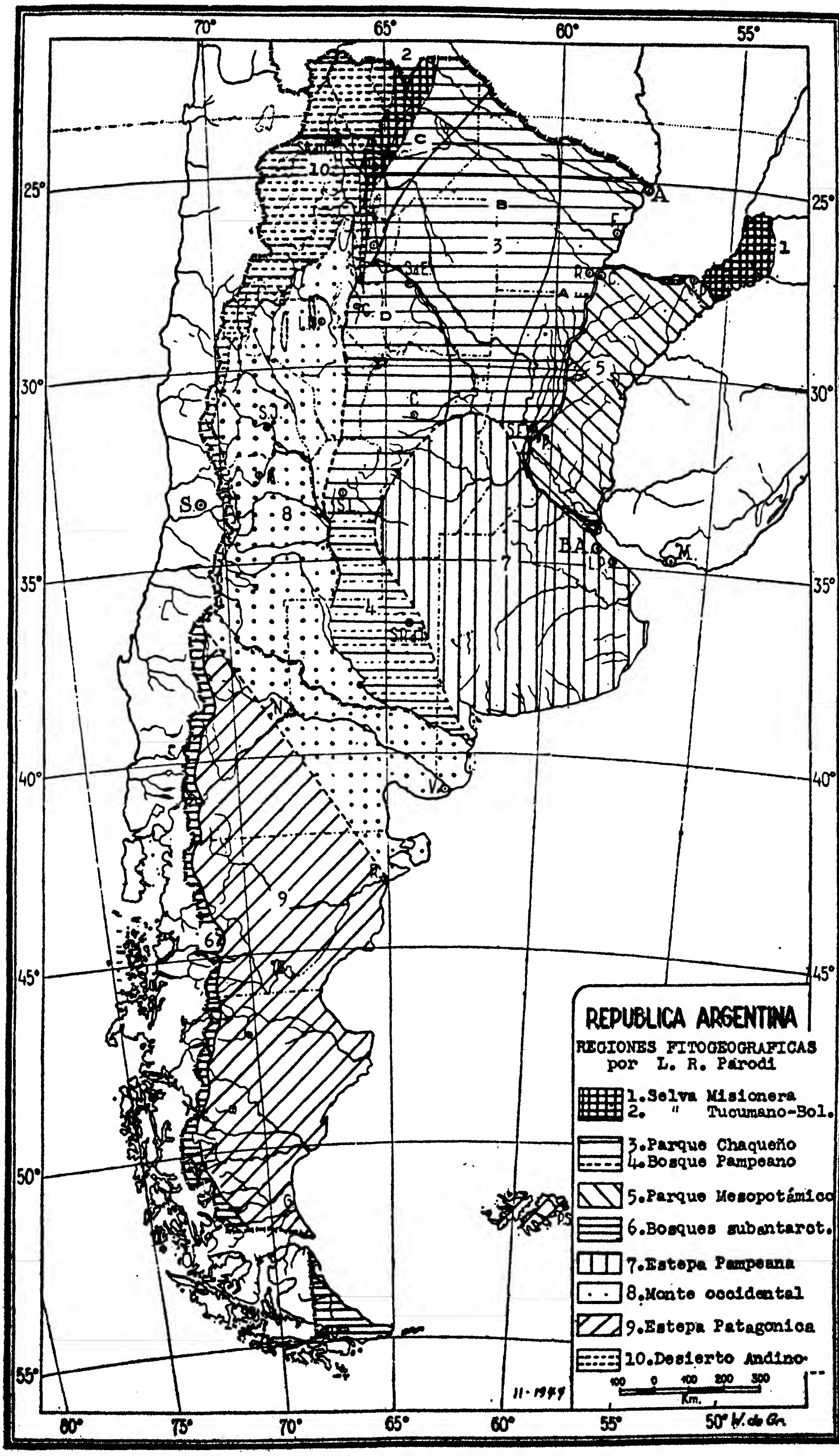
La especie característica es el caldén (*Prosopis caldenia*); éste crece comunmente agrupado dando al paisaje aspecto de parque, en cuyas abras predominan varias especies de gramíneas chaqueñas como *Elionurus viridulus, Setaria fiebrigii, Trichachne penicilligera, Trichloris pluriflora* y otras que bajan desde las laderas montañosas de Tucumán, Catamarca y Córdoba tales como *Stipa ichu, S. hypogona, Muhlenbergia circinata*, etc.; existen además especies propias como *Aristida subulata* y *A. trachyantha.*

El clima es templado y medianamente seco; las precipitaciones medias anuales oscilan entre 450 y 700 mm. El suelo es arenoso muy propenso a la erosión eólica después de roturado o desboscado; son comunes los médanos.

Entre las especies arborescentes o arbustivas que se asocian con el calden citaré varios *Prosopis* (*P. algarrobilla, P. striata, P. alpataco, P. humilis, P. nigra*), el chañar (*Gourliea spinosa*), el incienso (*Schinus polygamus*), el piquillín (*Condalia lineata*), el peje (*Jodina rhombifolia*), etc. Las jarillas (*Larrea*), tan características del Monte xerófilo occidental, a menudo están presentes en estos bosques, pero son escasas y dominadas por los caldenes.

El árbol más importante aquí es el calden.

5. *PARQUE MESOPOTAMICO.* — Comprende el suroeste de Misiones y las provincias de Corrientes y Entre Ríos hasta el Delta (Entreriano y Bonaerense) y los bosquecillos marginales de la ribera bonaerense hasta algo más al Sur de La Plata. La fisiografía es muy variable. En el suroeste de Misiones y noreste de Corrientes el suelo presenta amplias ondulaciones dejando depresiones por donde corren riachos bordeados por selvas en galería. En muchos sitios aparece la tierra roja de aspecto laterítico muy rica en hierro; en otros es arcillosa y en los bajos pantanosos hasta llega a ser turbosa. En el centro y sureste de Corrientes el suelo es ordinariamente llano pero en muchos sitios se han formado depresiones donde existen esteros, en algunos casos ex-


REPUBLICA ARGENTINA
REGIONES FITOGEOGRAFICAS
por L. R. Parodi
1. Selva Misionera
2. " Tucumano-Bol.
3. Parque Chaqueño
4. Bosque Pampeano
5. Parque Mesopotámico
6. Bosques subantarct.
7. Estepa Pampeana
8. Monte occidental
9. Estepa Patagonica
10. Desierto Andino
Km.
11-1947
W. de Gr.

tensísimos, como el del Iberá que tiene unos 7 à 8 mil kilómetros cuadrados de superficie (KUHN, 1922). El territorio entrerriano es igualmente muy heterogéneo, en ciertos lugares aflora la arenisca que origina cuchillas pedregosas, en otros el suelo es horizontal y areno-arcilloso soportando bosquecillos o estepas; en el sur o zona de Ibicuy es medanoso, y aluvional en el Delta. Las asociaciones que componen este vasto territorio fitogeográfico son muy diferentes, predominando las savanas, los bosques xerófilos y las selvas marginales, pero también existen palmares, estepas y praderas.

Entre los árboles más valiosos citaremos el ñandubay (*Prosopis ñandubay*) de madera durísima usado para elaborar carbón, el cebil (*Piptadenia* sp.), el urunday (*Astronium balansae*), el sauce criollo (*Salix humboldtiana*), el tala (*Celtis spinosa*), el lapacho (*Tecoma ipe*), el ibirá-pitá (*Peltophorum dubium*), etc.

Una zona forestal de gran importancia es el Delta donde pueden efectuarse cultivos forestales muy diversos entre cuyos más importantes pueden señalarse el aliso (*Alnus glutinosa*), el ciprés calvo (*Taxodium distichum*), el plátano (*Platanus acerifolia*), algunas tacuaras (*Bambusa* sp.) y numerosas especies de álamos (*Populus*), sauces y mimbres (*Salix*), etc.

El clima es templado-cálido: las temperaturas medias oscilan entre 17° y 21°, y en todo el territorio ocurren heladas en invierno. Las lluvias oscilan entre 950 mm en la ribera platense, ascendiendo hasta 1500 mm anuales en el suroeste de Misiones.

6. *BOSQUES SUBANTÁRTICOS.* — Estos bosques se extienden en una estrecha faja, no mayor de 100 km de ancho, a lo largo de la Cordillera andina, por los valles y faldas montañosas, desde el norte del Neuquén, 37°50′ lat. S. (RAGONESE, 1936), hasta Tierra del Fuego. Fitosociológicamente es una Provincia fitogeográfica bien definida, cuyo carácter fundamental es la presencia de varias especies del género *Nothofagus*.

Su clima es templado frío y húmedo; las temperaturas medias oscilan entre 5° y 13°; en el invierno nieva abundantemente en el norte y gran parte del año en el sur. Las precipitaciones oscilan entre 500 y 1500 mm según los lugares; la zona oriental es más seca que la occidental, donde hay puntos, como en Laguna de Frias (Nahuel Huapí), donde llueve más de 2000 mm.

Siguiendo a HAUMAN (1931) se distinguen dos distritos; uno septentrional, la *Foresta valdiviana*, que se extiende desde el norte del Neuquén hasta el paralelo 47° y el otro, los *Bosques magallánicos*, desde esta latitud hasta Tierra del Fuego.

El distrito valdiviano es el que ostenta la vegetación más abundante y la flora más rica. Las especies arbóreas más características de este distrito son el coihue (*Nothofagus dombeyi*), el ñire (*N. antarctica*), el radal (*Lomatia obliqua*), el ciprés (*Libocedrus chilensis*), el palo santo (*Flotowia diacanthoides*), una de las compuestas de mayor talla y valiosísima por su madera, el laurel (*Laurelia serrata*), el maniú (*Podocarpus nubigena*), el alerce (*Fitzroya cupressoides*), etc. En el norte de este distrito, entre los paralelos 37°45′ y 40°3′ se extiende una consociación muy interesante, la de *Araucaria araucana*, de madera valiosa para elaborar terciado y pasta para papel.

Se asocia a los árboles citados el coligue (*Chusquea culeou*) de hojas duras y de cañas sólidas, explotada para fabricar las lanzas del ejército. El distrito austral se caracteriza por la presencia del guindo (*Nothofagus betuloides*) cuya área septentrional llega hasta el sur del lago Pueyrredón; además *N. antarctica*, el canelo (*Drimys winteri*), el ten (*Pilgerodendron uviferum*), *Maytenus magellanica*, *Berberis* sp., etc. comunes a toda la formación.

Las especies forestales más importantes son los *Nothofagus* (*N. procera*, *N. antarctica*, *N. obliqua*, *N. betuloides*), el ciprés (*Libocedrus chilensis*), la *Araucaria araucana*, *Fitzroya cupressoides*, *Lomatia obliqua*, etc.

7. *ESTEPA PAMPEANA.* — Forma el tapiz vegetal que cubre toda la provincia de Buenos Aires, el sur de Santa Fe, y el sudeste de Córdoba. Su extensión es aproximadamente de 500.000 km cuadrados.

El clima es templado; las temperaturas medias anuales oscilan entre 14° y 19°, ocurriendo heladas bastante intensas durante el invierno. Las lluvias fluctuan entre 500 mm en el sudoeste y 1000 mm en el noreste, repartidas en unos 50 a 80 días; las épocas lluviosas corresponden a la primavera y al otoño.

El suelo está constituido por loes y es relativamente homogéneo; en la zona oriental es arcilloso y compacto, mientras en la occidental es arenoso, más o menos suelto, y expuesto a la erosión eólica. Naturalmente es una estepa herbácea, con predominio de gramíneas y falta total de árboles.

Las gramíneas más frecuentes y características pertenecen a los géneros *Stipa*, *Piptochaetium*, *Aristida*, *Poa*, *Briza*, *Melica*, *Eragrostis*, *Hordeum*, *Sporobolus*, *Bromus*, *Andropogon*, etc. Hay pocas especies de paniceas pero algunas de ellas suelen ser abundantes como *Panicum bergii*, *Paspalum plicatulum*, *P. dilatatum*, *Setaria geniculata*. A ellas se les asocian especies de *Verbena*, *Vernonia*, *Aster*, *Gnaphalium*, *Soliva*, *Oxalis*, *Adesmia*, *Solanum*, *Carex*, *Juncus*, *Sisyrinchium*, etc.

Por causa de su suelo fértil y apropiado para los cultivos herbáceos mesotérmicos (cereales, oleaginosas y alfalfa), ha sufrido una transformación profunda, siendo hoy difícil hallar lugares con la estepa pristina para poder estudiarla.

Aunque naturalmente carece de árboles, ellos crecen bien cuando se los cultiva. La falta de árboles se debe, como ya fué expresado (PARODI, 1942*a*) al suelo compacto y poco aereado y a la mala distribución de las lluvias, faltando el agua generalmente durante el verano. Dado que prodigándoles cultivo apropiado los árboles crecen bien, es posible la forestación del territorio siempre que se elijan especies adecuadas para este medio.

Las especies ya aclimatadas, y que por su desarrollo parecen ser las más convenientes, son las siguientes: *Eucalyptus* (*E. globulus* en el este y *E. viminalis* en el oeste), el paraíso (*Melia azedarach*), la casuarina (*Casuarina cunninghamiana*), el plátano (*Platanus acerifolia*), el sauce llorón (*Salix babylonica*), los álamos (*Populus*), la acacia blanca (*Robinia pseudacacia*), la acacia negra (*Gleditschia triacanthos*), el olmo (*Ulmus campestris*), los pinos (*Pinus halepensis*, *P. insignis* y *P. pinaster*), los robles (*Quercus pedunculata*, etc.), el árbol del cielo (*Ailanthus altissima*), los fresnos (*Fraxinus* sp.), etc. Como se puede notar, salvo *Eucalyptus*, *Casuarina*, *Pinus*, que son especies xerófilas, las demás son especies de hojas caedizas.

8. *MONTE OCCIDENTAL.* — Ocupa la región seca que se extiende por las laderas mon-

tañosas desde el norte de Catamarca hasta la línea oblicua establecida por HAUMAN (1926: 164) que va desde el norte del Neuquén, hasta la desembocadura del río Chubut, y desde la precordillera andina, hasta los bosques de transición en Catamarca y Córdoba, los bosques de caldenes de la Pampa Central, y el litoral atlántico en el sur del Río Colorado. Es una vegetación intensamente xerófila con predominio de arbustos espinosos de 1 a 3 m. de altura; contiene pocos árboles aislados y el suelo es desnudo en alta proporción; a menudo el grado de cobertura fluctua entre 10 y 20%; las gramíneas son escasas y el cesped herbáceo — tan característico en el Chaco — es aquí exiguo o falta totalmente.

El suelo es horizontal en la zona oriental y accidentado en la región cordillerana; suele ser gris, arenoso, ripioso y en muchos lugares salado. El clima es templado-cálido y muy seco; las medias anuales fluctúan entre 13° en el sur y 19° en el norte. Las lluvias oscilan entre 200 y 400 mm y se producen en máxima parte desde la primavera al otoño.

Entre los arbustos más característicos debemos mencionar las jarillas (*Larrea divaricata, L. nitida* y *L. cuneifolia*), en ciertos puntos predominantes; la brea (*Cercidium praecox*), la jarilla macho (*Zucagnia punctata*), la chica (*Ramorinoa girolae*), varios *Prosopis* (*P. strombulifera, P. striata, P. argentina, P. alpataco, P. chilensis*, etc.), el chañar (*Gourliea spinosa*), *Monttea aphylla, Lycium* sp., *Chuquiragua* sp., *Acacia* sp., *Bougainvillea* sp., *Bulnesia, Atamisquea emarginata*, etc. y un buen número de cactáceas. Las gramíneas son escasas pudiendo ser señaladas especies de *Aristida, Stipa, Bouteloua, Trichloris, Setaria, Sporobolus, Pappophorum, Trichachne*, etc. y *Panicum urvilleanum* en los suelos arenosos.

Sólo pueden efectuarse los cultivos bajo regadío; se crían bien los árboles de hojas caedizas, pero su cultivo no es económico ni puede competir con los frutales y sólo se limita a usos domésticos.

9. *ESTEPA PATAGÓNICA.* — Es una estepa de arbustos xerófilos achaparrados, menores de 1 m, mezclados con algunas gramíneas, dejando parcialmente desnuda la superficie del suelo.

Ocupa la Patagonia seca desde su límite con el Monte occidental, hasta el estrecho de Magallanes; al este limita con el litoral atlántico desde la desembocadura del río Chubut hacia el sur, y al oeste con los bosques subantárcticos.

El clima es templado-frío, muy seco y constantemente azotado por vientos fuertes. Nieva frecuentemente en el invierno. Las temperaturas medias anuales varían desde 6° en el sur hasta 13° en el norte; las lluvias oscilan entre 150 y 300 mm, produciéndose en máxima parte durante la época cálida.

El suelo es arenoso o pedregoso y seco en las mesetas, y húmedo en los cañadones, donde se forman amplios mallines con vegetación pratense a base de *Poa, Festuca, Agrostis, Deschampsia, Carex, Juncus*, etc. En las mesetas predomina la vegetación arbustiva, baja, en forma de cojines; los géneros más comunes son *Berberis, Azorella, Verbena, Nardophyllum, Chuquiragua, Mulinum, Lepidophyllum, Adesmia*, etc.; resguardadas en dichas matas viven algunas gramíneas xerófilas de los géneros *Stipa, Poa, Hordeum, Agropyron, Bromus, Trisetum*, etc. Salvo en algunos lugares reparados, con suelo húmedo, donde pueden cultivarse algunas especies arbóreas para usos locales, no es posible el cultivo de forestales en esta región.

10. *DESIERTO ANDINO.* — Se extiende por la Puna de Atacama y altas montañas andinas a más de 3000 m s.m. en el norte, bajando a menos de 2000 m desde el Neuquén hacia el sur. Es región de vegetación pobre y achaparrada; sólo en las quebradas y en las laderas próximas al altiplano crecen algunos árboles achaparrados como *Prosopis ferox*, que suele ser cortado para combustible, y el cardón (*Cereus pasacana*) de varios metros de altura; éste proporciona una madera muy curiosa, con grandes perforaciones equivalentes a los radios medulares, muy estimada para elaborar pequeños muebles y numerosos objetos de fantasía.

La dificultad para cultivar árboles y la falta de otros combustibles, son causas que se oponen a la vida del hombre en la Puna.

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LORENZO R. PARODI: **La Agricultura en la República Argentina:** — La agricultura representa la fuente primordial de la riqueza argentina. Por su posición entre los paralelos 22° y 55° del continente sudamericano, y por su extensión, abarcando cerca de 3 millones de kilómetros cuadrados, comprendiendo llanuras y regiones montañosas, el suelo y clima de la República Argentina permiten los cultivos más variados comprendiendo especies megatérmicas y microtérmicas.

Salvo los cultivos megatérmicos perennes más exigentes, como el cacao, el caucho, la quina, etc., los otros cultivos se practican sin inconvenientes ecológicos, siendo posible aumentar su área a medida que el consumo lo exija. En cuanto a las especies magatérmicas antes citadas, todavía no se han hecho ensayos que demuestren que su cultivo no es posible en las regiones tropicales húmedas de Misiones y Orán (Salta). Es indudable que seleccionando razas apropiadas a dichas condiciones, su cultivo ha de resultar factible en los territorios aludidos.

Actualmente la riqueza agrícola principal proviene del cultivo de los cereales y del lino, destacándose el trigo y el maíz por la extensión y cantidad cosechada.

Cinco de las ocho regiones naturales en que por su clima y suelo se divide el país contienen cultivos fundamentales para la economía argentina; por órden de importancia ellas son: 1) *la vasta llanura pampeana,* aproximadamente de medio millón de kilómetros cuadrados consagrada a los cereales, lino y alfalfa; 2) *la región xerófila occidental* dedicada a cultivos regados, sobre todo vid, frutales mesotérmicos y hortalizas de fruta y semilla; 3) *la Mesopotamia,* caracterizada por sus variados cultivos megatérmicos y mesotérmicos entre los que sobresalen los Citrus, tabaco, cereales, etc., y la yerba mate en el territorio de Misiones; 4) *el Chaco,* dedicado principalmente al algodón; 5) *la zona occidental* chaqueña de transición a la selva Tucumano-oranense, dedicada a la caña de azúcar, tabaco, hortalizas, etc.

*Cereales* (8)

Se calcula en algo más de 17 millones de hectáreas los cultivos de cereales en la República Argentina; esta dilatada superficie se encuentra principalmente en la provincia de Buenos Aires, pero ocupa también gran parte de las provincias de Santa Fé, Córdoba y Entre Ríos. Es una vasta región con suelo loéssico muy profundo y fértil, sumamente horizontal, originalmente cubierto por la estepa pampeana. Merced a su clima templado, cuyas temperaturas más bajas apenas descienden algunos grados bajo 0°, y lluvias que fluctuan entre 700 y 1000 mm, distribuidas casi todo el año (salvo uno o dos meses invernales), pueden cultivarse sin riego, casi todas las especies mesotérmicas. La región es muy pródiga para los cereales, que aquí se cultivan sin abonos. El maíz, cultivo estival, sufre a veces por la falta de agua en la primera quincena de enero; aunque por esta causa disminuye el rinde, rara vez llega a perderse este cereal por falta total de aquel elemento; antes bien, al norte del paralelo 34° durante los años lluviosos el cultivo del maíz puede efectuarse después de cosechado el trigo, lo que representa dos cosechas por año. Esta segunda cosecha se obtiene sembrando variedades precoces antes del 15 diciembre. Las superficies cultivadas por cada agricultor oscilan entre 20 a 30 hectáreas, en las regiones donde la propiedad está más dividida, hasta 500 ó más hectáreas en las zonas menos favorecidas por las lluvias. Merced a las condiciones del suelo las diversas operaciones agrícolas se efectuan casi exclusivamente por medio de instrumentos mecánicos.

*Trigo:* — Este cultivo abarca alrededor de 7 y ½ millones de hectáreas con una producción casi de 7 millones de toneladas de granos, de los que más del 50% se exportan. La especie más cultivada es *Triticum aestivum,* representando casi el total del área, pero, en forma esporádica, en una u otra localidad se cultivan pequeñas superficies de *T. durum* y *T. polonicum,* ambos destinados a la elaboración de semola y, a veces, a fideos de calidad. Las tres especies citadas, ordinariamente acompañadas por *T. turgidum,* se cultivan también en los valles andinos y preandinos del noroeste, si bien en pequeñas superficies no mayores de 2 a 3 hectáreas.

La calidad de los trigos tiernos y semiduros, destinados a la elaboración del pan, ha sido muy mejorada durante los últimos años, contribuyendo a ello un cierto número de estaciones experimentales dependientes del Ministerio de Agricultura de la Nación, de las provincias, de los ferrocarriles o de propiedad particular. Una dependencia del Ministerio de Agricultura, la División Producción de Granos, está dedicada a la creación y control de las nuevas variedades.

*Maíz:* — El área cultivada sobrepasa los 6 millones de hectáreas con una producción superior a 8½ millones de toneladas. Su cultivo en el país data desde antes del descubrimiento de América, habiendo sido practicado por todas las tribus de aborígenes que conocieron la agricultura. Todavía hoy, indios y mestizos de la zona montañosa del noroeste y de algunas localidades de la Mesopotamia, tienen en cultivo numerosas variedades de maíces indígenas, pertenecientes en máxima parte a *Zea mays amylacea.* Las variedades comerciales, destinadas casi exclusivamente a la exportación, pertenecen a *Z. mays indurata,* representando alrededor del 95% de la producción total. Las variedades denominadas diente de caballo (*Z. mays indentata*), se cultivan en pequeña proporción y están des-

tinadas a pienso. En cuanto a *Z. mays saccharata* y *Z. mays amyleasaccharata* son cultivos hortícolas cuyo producto se expende fresco bajo el nombre de choclo.

*Arroz:* — Varias provincias argentinas ofrecen condiciones favorables para el cultivo del arroz, el cual año tras año va adquiriendo mayor importancia en la economía nacional. Por ahora su cultivo está circunscripto en máxima parte a las provincias de Tucumán y Corrientes, pero podrá extenderse considerablemente a medida que se requiera aumentar la producción; su área actual es de unas 30500 hectáreas con un rendimiento de 57 mil toneladas de grano. (Comm. L. FOULON).

*Avena:* — Se cultivan aproximadamente un millón y medio de hectáreas destinadas casi exclusivamente a forraje, sea para pastoreo invernal, o grano seco para pienso. Se siembra en máxima proporción *Avena byzantina* por ser más resistente al pisoteo y adaptarse mejor a las condiciones ecológicas pampeanas. *A. sativa,* más apropiada para grano, es poco cultivada en la región pampeana por no prosperar bien en este clima templado-cálido y no soportar debidamente el pisoteo del ganado.

*Cebada:* — De las 700 mil hectáreas que aproximadamente se cultivan en el país, más de 450 mil corresponden a variedades cerveceras; estas se hallan distribuidas principalmente en el sudoeste de la provincia de Buenos Aires y gobernación de la Pampa Central. Pequeñas superficies destinadas a forraje invernal, sobre todo para vacas lecheras y animales de trabajo, se hallan cultivadas por toda la región de los cereales.

*Centeno:* — Se cultiva sobre todo para forraje de invierno en la zona occidental, seca y arenosa, de la Estepa pampeana, y en la Pampa Central. Gracias a su rusticidad resiste mejor que otras forrajeras a las condiciones edafológicas de la región aludida; el área cultivada en todo el país sobrepasa de 1.200.000 hectáreas.

*Otros granos:* — A parte de los cereales mencionados se cultivan otros, pero siempre en escasa proporción y en forma esporádica; merecen citarse algunos sorgos graníferos (*Sorghum caffrorum,* etc.), alpiste (*Phalaris canariensis*), mijo (*Panicum miliaceum*), etc.

### *Oleaginosas*

*Lino:* — Representa la especie anual más importante después del trigo y maíz. La zona de cultivo se superpone parcialmente con la del trigo, pero por exigir más temperatura su área se halla desplazada hacia el norte de la de dicho cereal. Todo nuestro lino está destinado a la producción de semilla para aceite; se calcula en algo más de 3 millones de hectáreas la superficie sembrada en los últimos años, con una producción de 2 millones de toneladas de semillas, lo que coloca a la Argentina como primer país productor de esta oleaginosa. Salvo una parte destinada a la industria local, casi toda la cosecha es exportada.

La industrialización de la paja para hilado, no obstante los resultados halagadores obtenidos por los ensayos que se han hecho, hasta ahora no ha logrado ningún incremento como tal.

*Tung:* — Es una de las plantas industriales más recientemente introducida en la Argentina. Está representada principalmente por *Aleurites Fordii* que ha hallado condiciones favorables para su crecimiento en la región Mesopotámica desde Misiones hasta Entre Ríos; la superficie cultivada pasa ya de las 3500 hectáreas, y podrá aumentarse notablemente a medida que se intensifique la demanda de semillas (14).

*Ricino:* — Ha merecido un marcado incremento en los últimos años merced al empleo de sus semillas para la elaboración de aceites industriales. La provincia de Corrientes ofrece condiciones ideales para su cultivo, habiéndose naturalizado en diversas localidades. También ofrecen muy buenas condiciones para su cultivo las provincias de Salta, Tucumán, territorio del Chaco, etc.

*Oleaginosas comestibles:* — Entre las oleaginosas herbáceas empleadas para la extracción de aceites comestibles deben mencionarse el girasol, el maní y el algodón.

*Maní:* — El cultivo de *Arachis hypogaea* en el norte argentino data de épocas anteriores a la Conquista, pues los Guaraníes lo cultivaban junto con otras especies útiles. La superficie sembrada actualmente alcanza a unas 127 mil hectáreas, en máxima parte en la provincia de Córdoba; sin embargo, el cultivo, aunque sea en pequeña escala, se practica en todas las provincias al norte del paralelo 33°. La producción máxima alcanzó hace algunos años a 80 mil toneladas, pero recientemente ha sufrido una merma causada por el incremento alcanzado por el cultivo del girasol.

El cultivo del *girasol,* con fines industriales, ha comenzado hacia 1920, pero su gran importancia la ha adquirido en los últimos años. Por ser más fácil su cultivo, producir mejor aceite y crecer en un área geográfica mayor, está reemplazando al maní. El área sembrada en 1939-40 sobrepasó las 500 mil hectáreas con una producción aproximada de 370 mil toneladas de granos. En la actualidad se están realizando estudios para establecer cuales son las variedades productoras de aceite más adecuadas para cada región.

A parte de los citados, tiene gran importancia el aceite de algodón, elaborado con la semilla de dicho textil, y que, siendo un subproducto de aquel, que da muy buen aceite, puede competir con las especies similares. La soja, con todas sus ventajas, sobre todo porque aumentaría la fertilidad del suelo, lo que no occurre con el girasol que es muy esquilmante, queda casi desconocida en la Argentina como oleaginosa comestible.

Además de las anteriores, merece señalarse el nabo (*Brassica campestris*), del que existen cultivos en el sudoeste de la provincia de Buenos Aires, sin embargo, gran parte de la semilla del comercio proviene de la limpieza del lino, en cuyo cultivo crece adventicio.

### *Frutales* (8)

La fruticultura argentina está en vías de acentuado progreso, tanto por el aumento constante del área cultivada, cuanto por el mejoramiento de las variedades y métodos culturales. Por su calidad, sabor y buen aspecto nuestras frutas frescas como las uvas, peras, manzanas y duraznos, pueden competir con las mejores del extranjero. Favorece al mercado de exportación la situación geográfica del país en el hemisferio sur, permitiendo ofrecer los productos a los centros de consumo europeos o norteamericanos en la época que allá faltan tales frutas.

Dejando a parte la vid y el olivo, que trato más adelante, los cultivos de mayor importancia son los que corresponden a las especies cítricas, distribuidos principalmente en la région Mesopotámica, y los manzanos, perales, durazneros y

ciruelos, en la zona templada (Río Negro, Mendoza, Buenos Aires, Córdoba, etc.).

El área actual de unas 120 mil hectáreas, es reducida si se piensa que todavía se importa fruta, sobre todo seca. Además el consumo interno es deficiente como se infiere por la dificultad de obtener fruta a bajo precio, aún en las épocas de mayor abundancia.

Merced a la diversidad de climas y suelos, se cultivan en el país las más diversas especies de frutales, desde las microtérmicas, como ciertas variedades de manzanos, grosellas etc., hasta las megatérmicas como las chirimoyas, paltas, bananas, etc.

Mucho hay que hacer aún, sin embargo, en el mejoramiento de los frutales, sobre todo de fruta seca como nueces, almendras, castañas, avellanas, higos, etc. Hay regiones que resultarán favorables para tales cultivos como las diversas provincias andinas, pero es necesario una labor experimental previa para establecer las mejores variedades y las condiciones ecológicas más convenientes para cada una de ellas.

*Viña:* — Este cultivo puede calcularse en algo más de 126 mil hectáreas, con una producción aproximada de 1.306.000 toneladas de las que más de un millon se dedica a elaboración de vino, quedando el resto para mesa y para pasa. Corresponde a las provincias de Mendoza y San Juan más del 85% de la producción total, perteneciendo el resto a Río Negro, La Rioja, Catamárca, Córdoba y Salta; también en las otras provincias existen cultivos cuyo producto es ordinariamente absorbido por las necesidades locales. El área de esta planta puede ser aumentada considerablemente, pero hasta ahora la exportación es limitada, y la producción de vino, y uva de mesa, bastan para el consumo interno. Una ley nacional regula el cultivo de esta especie.

*Olivo:* — El cultivo de esta especie está en el período de franco acrecentamiento en el país; actualmente alcanza a una superficie de 5 mil hectáreas, pero, día a diá se le suman nuevas superficies debido a la preocupación que por esta planta tienen casi todas las provincias. Los cultivos más importantes estan en Mendoza, siguiéndole luego. San Juan y Entre Ríos. En La Rioja su cultivo data desde la época colonial, pero solo en los últimos años ha alcanzado importancia económica. El clima de la región andina favorece su desarrollo cuya fructificación comienza a los 4 o 5 años. La reproducción por semilla ha resultado fácil en aquel medio, siendo común ver, en Catamarca, al pié de los árboles en producción, almácigos de plantitas nacidas de las semillas allí caídas.

*Plantas sacaríferas* (8): — La industria azucarera argentina abastece totalmente el consumo interno. Casi toda la materia prima para la industria es obtenida de la caña de azúcar. Su cultivo está distribuido en dos zonas subtropicales diferentes: la más importante en la región subtropical de transición con el chaco de las provincias de Salta, Jujuy y Tucumán; a esta última le corresponde más del 50% del total; la segunda región comprende el noroeste de Corrientes, el Chaco y noreste de Santa Fé. El área total cultivada en 1936-37, fué algo más de 187,500 hectáreas con una producción superior a 5 millones de toneladas de caña, de las que 4,870,000 fueron industrializadas. La cantidad de azúcar elaborada excedió las 433 mil toneladas, lo que superó a nuestras necesidades, quedando un sobrante destinado a la exportación. Si las exigencias lo requiriesen el área de cultivo podría ampliarse convenientemente.

La remolacha azucarera ocupa un lugar secundario, no obstante ser un cultivo que podría realizarse en una amplia zona de nuestro país. En la actualidad existen cultivos en Río Negro y algunas localidades de la provincia de Buenos Aires.

*Tabaco* (8): — Hasta hace poco más de una década gran parte del tabaco consumido en el país provenía del extranjero, pero merced a la introducción de cultivares exóticas refinadas como la Virginia, Bahia, Kentucky, etc. se ha mejorado la calidad, y hoy nuestros cultivos satisfacen en máxima parte las exigencias internas. En 1937 el cultivo alcanzó aproximadamente a 11,000 hectáreas, con una producción superior a 9,500 toneladas. El área de cultivo puede extenderse notablemente en el país, pero en la actualidad está limitada, en máxima parte, al territorio de Misiones y a las provincias de Corrientes y Salta.

*Textiles:* — De esta agrupación económica el género más importante es el algodón (*Gossypium*) del que se cultivan dos especies: *G. hirsutum*, el más difundido, alcanzando quizá al 80% del área total, y *G. barbadense* en menor cantidad. El área total abarca hoy unas 400 mil hectáreas (9) distribuidas principalmente en el territorio del Chaco, que ofrece condiciones muy apropiadas para este cultivo. El área aludida puede ser aumentada considerablemente (4 o 5 veces, o quizás más) a medida que aumenten los pedidos, los precios sean más remuneradores para los agricultores, y haya posibilidad de obtener mano de obra para su cultivo y cosecha.

Actualmente la industria nacional consume el 50% de la producción, siendo exportado el resto; la exportación podrá aumentar notablemente merced a la buena calidad de nuestros algodones de fibra mediana y a sus precios no elevados (9).

En el Delta paranense, se cultiva con buenos resultados *Phormium tenax*, del que en 1937 se han cosechado casi tres mil toneladas, destinadas a la industria local.

En la provincia de Santa Fé existen sembrados de cáñamo, cuya superficie apenas supera las 100 hectáreas, lo que demuestra la posibilidad de implantar este cultivo en mayor escala si la industria lo requiere.

Queda expresado ya que el lino, aunque se cultiva en vasta escala para la semilla, solo excepcionalmente es empleado para extraer su fibra.

*Hortalizas* (8): — Exceptuando las papas, batatas y mandioca, el área de las hortalizas abarca alrededor de 225 mil hectáreas en la Argentina. La producción se consume casi totalmente en el país; se exportan algunas partidas de lentejas, garbanzos, lupinos, habas y porotos, y se importan frecuentemente cantidades variables de semillas de alverjas partidas, y ciertas variedades de porotos.

El cultivo es efectuado en huertas de dos tipos:

1. Las huertas propiamente dichas, dedicadas a múltiples especies, sobre todo legumbres de hojas o de raíz (forzando su cultivo), distribuidas cerca de las grandes ciudades para abastecerles las verduras más necesarias, como las que se hallan al norte de la Capital Federal.

2. Las huertas especializadas, generalmente alejadas de los centros de consumo y consagradas a determinadas especies cuyos frutos, u órganos alimenticios, permiten el transporte a largas distancias; de este tipo son las de Médanos (Sur de la provincia de Buenos Aires) consagradas al cultivo del ajo; las de Cruz del Eje (Córdoba) y Trancas (Tucumán), dedicadas a los garban-

zos; las de Mendoza, Jujuy y Salta a los ajíes, tomates y berengenas; las de Tucumán, Santa Fé y Corrientes a las alverjas, etc. El costo del transporte está compensado por el alto rendimiento que se obtiene en dichas regiones, favorecidas por la calidad de los suelos y la eficiencia del clima. Las cercanías de la Capital Federal, hacia el suroeste, ofrecen todavía un campo propicio a la horticultura; son campos de extensión variada, dedicados a tambos o a pastoreo del ganado, siendo que el suelo produciría mucho más si se lo destinara a cultivos intensivos.

En cuanto a la papa se calcula un área media de 150 mil hectáreas (4), con una producción de unas 790 mil toneladas, de las que suele exportarse un sobrante de unas 50 mil toneladas. Aunque su cultivo se practica en todas las huertas del país, existen centros especializados como Balcarce, oeste de Buenos Aires, sudeste de Santa Fé, Cuyo y Río Negro, donde se produce casi toda la papa de nuestro comercio. En el sudeste de Santa Fé y en la zona llana de Mendoza se obtienen normalmente dos cosechas por año.

Son importantes, además, la mandioca (*Manihot*), y la batata (*Ipomoea batatas*), la primera confinada a Corrientes y Misiones y empleada en la alimentación, sea fresca o en forma de harina; le segunda, mucho más importante, ocupa un área casi el doble (26 mil hectáreas) y se cultiva en casi todo el país.

*Forrajeras:* — El cultivo de las forrajeras tiene una considerable importancia en la Argentina por ser la ganadería la segunda fuente de nuestra riqueza. El cultivo básico es la alfalfa con una superficie de 5,300,000 hectáreas (8), pudiendo atribuirse a está forrajera el éxito de nuestra ganadería más refinada. Es sabido que una elevada proporción de la ganadería argentina se alimenta en campos naturales, donde predominan las gramíneas, diversas leguminosas herbáceas, geraniáceas, compuestas, etc., sin embargo, el ganado más refinado, sobre todo vacuno destinado a carnicería y exportación, está criado en campos de pastoreo, principalmente a base de alfalfa, que en nuestro clima produce forraje durante los 8 a 9 meses más cálidos del año. Un pasto natural, valioso como forraje invernal, es la cebadilla criolla (*Bromus unioloides*), bienal, muy resistente al pisoteo y fácil de propagarse por semillas.

En la zona subtropical se ha difundido con éxito la grama de Rhodes (*Chloris Gayana*) a menudo alternando con los sorgos forrajeros, uno de los cuales *Sorghum sudanense*, sobrepasa las 80 mil hectáreas, cultivándose con buen resultado hasta el sur de Buenos Aires.

En la región pampeana, donde la ganadería es más intensiva, se emplea, además de la alfalfa, los varios cereales invernales (avena, cebada, centeno, etc.) reemplazados a veces por la cebadilla, el ray-grass, o el alfarín (*Phalaris minor*). Poco se han difundido hasta ahora las forrajeras de tubérculos o raíces carnosas; existen pequeños cultivos de remolacha y rape en la provincia de Buenos Aires. En cuanto a la conservación de forrajes se emplea principalmente la alfalfa seca, que, para los animales estabulados, se acompaña con granos de avena, cebada o maiz. La conservación de forrajes en silos está muy poco difundida todavía.

*Cultivos varias:* — Una mención especial merece aquí el cultivo de la yerba mate (*Ilex paraguariensis*); la infusión de las hojas sazonadas y debidamente preparadas, representa la bebida nacional.

En la actualidad existen extensas plantaciones en Misiones y Corrientes, alcanzando a un área superior a 63 mil hectáreas (8), lo que basta para nuestro consumo. Para evitar la sobresaturación del mercado interno, con perjuicio para los plantadores, una Comisión Nacional regula el comercio y producción de este artículo. La yerba mate es un árbol, no muy grande, dioico, semejante a un naranjo, que se reproduce por semilla. Es planta megatérmica que debe cultivarse en regiones cálidas y húmedas; las plantaciones se asemejan a las de naranjos. La planta comienza a producir a los 5 años pero recién a los 10 años entra en plena producción. La cosecha de las hojas se practica cuando llegan a sazón, y es necesario hacerla aplicando una poda adecuada para evitar el debilitamiento del árbol y su envejecimiento prematuro. Las hojas y ramas sufren un interesante proceso de desecación y sazonamiento en silos antes de ser molidas y estar en condiciones de ser empleadas.

*Plantas aromáticas:* — El cultivo de plantas aromáticas es aún incipiente. En los últimos años ha comenzado a cultivarse en cierta proporción (300 o 400 hectáreas) el comino y el anís, casí exclusivamente en Andalgalá (Catamarca). En la actualidad existe un gran interés por las especies aromáticas cuyas esencias son empleadas en confitería y licorería.

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LUCAS A. TORTORELLI: **Los Bosques Argentinos y sus Industrias Derivadas:** — *Historia del movimiento forestal del país.* — El movimiento forestal argentino efectivo comienza en el año 1878, con la exportación de rollizos de quebracho colorado chaqueño (*Schinopsis balansae*) a una fábrica de extractos vegetales de la ciudad de El Havre (Francia).

Algunos años después, en 1888, dicha exportación llegó a 2.121 toneladas de rollizos y, como la calidad y rendimiento del producto eran muy altos, su exportación fué en rápido ascenso, llegando en 1934 al record con 232.655 toneladas de extracto de quabracho, elaboradas totalmente en al país.

La primera fábrica de extracto de quebracho se instaló en la Argentina en 1880 en Empedrado (Corrientes). En la actualidad existen más de 20 fábricas ubicadas en los territorios del Chaco y Formosa y provincias de Santa Fé, Corrientes, Jujuy y Santiago del Estero; algunas de ellas se hallan paralizadas debido a las restricciones originadas por la limitación de la exportación.

El resto del movimiento forestal argentino es bastante escaso; tan solo se reduce a la exportación de durmientes de quebracho colorado santiagueño (*Schinopsis lorentzii*) a Bolivia, Estados Unidos de Norte América, Paraguay y Uruguay.

Respecto a la exportación de otras maderas pueden citarse: rollizos de algarrobos (*Prosopis* spp.) y postes de algarrobo y quebracho colorado santiagueño a Uruguay y Bolivia.

La importación de productos forestales en todas sus formas, en cambio, es muy alta. Solo en maderas y sus artefactos se importó en 1942 por valor efectivo m$n 107.000.000. Y esa cifra no era más baja antes del actual conflicto, ya que en 1937 era de m$n 80.000.000. La importación de maderas compensadas y chapas es también muy alta ya que en 1942 pasaba los m$n 13.000.000 (valores de tarifa) y en 1937 era aún más alta pues llegaba a los m$n 24.000.000. La mayor importación de maderas compensadas provenía antes de la guerra, de Finlandia, Polonia, Francia y ahora de Brasil, Chile y Estados Unidos de Norte América. Actualmente importamos vigas, rollizos, tablas y tablones de Chile y Brasil. También somos fuertes importadores de papel y pasta de madera y celulosa de madera sueca y finlandesa para fabricar papel.

*Legislación Forestal.* — La Argentina no tiene Ley de Bosques. En lo que respecta a los bosques del Estado se regía hasta hace poco, por tres artículos forestales existentes en la Ley de Tierras N° 4167 del 8 de Enero de 1903 y por varios artículos, decretos, resoluciones y disposiciones dictados en distintas oportunidades.

La legislación provincial en materia forestal es también bastante primitiva, ya que sólo se limita a acordar autorización para la tala, mediante el pago de impuestos variables.

Sin embargo esta situación ha sufrido un cambio últimamente, ya que por Decreto n° 15.317 del 27 de Noviembre de 1943 el Poder Ejecutivo Nacional creó la Dirección Forestal dependiendo del Ministerio de Agricultura de la Nación y varias provincias como Tucumán, Salta y Buenos Aires se hallan empeñadas en la preparación de sus leyes forestales.

Las primeras inquietudes legislativas tendientes a dotar al país de su Ley Forestal datan de Septiembre de 1915, en que se presentó a la Cámara de Diputados un Proyecto de Ley, que, sin embargo, no prosperó. Desde entonces hasta 1937 no hubo movimiento en este sentido. Pero en el año citado el Poder Ejecutivo creó una Comisión Consultiva Nacional de Bosques cuya misión más importante era la de asesorar al Ministerio de Agricultura en asuntos forestales y redactar un proyecto de Ley Forestal.

La Comisión Consultiva Nacional de Bosques presentó su primer proyecto de Ley, el 11 de Febrero de 1938 sin mayor éxito. Posteriormente se elevó otro proyecto, el 10 de Junio de 1942 que constaba de 129 artículos; el mismo se refería especialmente a la conservación de los bosques, su explotación racional, formación de nuevas masas forestales, ordenamiento de la industria maderera, etc.

En el citado proyecto de la Comisión Consultiva Nacional de Bosques se proponía someter a las disposiciones de la Ley todos los bosques y suelos forestales sean el los de propiedad particular o del Estado. Se declaraban por lo tanto de utilidad pública los bosques o terrenos necesarios para el cumplimiento de los planes de forestación, reforestación y demás trabajos silvícolas. Este proyecto corrió igual suerte que los anteriores ya que no llegó a ser tratado por el Congreso Nacional.

Entre las tareas que está realizando la Dirección Forestal, se encuentra la confección de un proyecto de Ley Forestal que ha de presentar al Ministerio de Agricultura antes del 30 de Julio próximo.

*Organización del servicio forestal en la Argentina.* — La reciente creación de la Dirección Forestal del Ministerio de Agricultura de la Nación, ha motivado la tarea de organización de dicho servicio. El nuevo organismo será el encargado de administrar los bosques del Estado y de realizar estudios y trabajos técnicos y científicos en los bosques del país. Dichas tareas eran dificultosamente cumplidas hasta hace algunos meses por la División de Bosques de la Dirección de Tierras y por la División Forestal de la Dirección de Agricultura.

La actual Dirección Forestal comprende tres grandes Divisiones denominadas: División Silvicultura, División Tecnología de Maderas y División Administración de Bosques y su estructura puede apreciarse en el gráfico que se acompaña.

Entre las tareas más importantes del plan por llevarse a cabo por medio del nuevo organismo, se destaca la de confeccionar el Mapa Forestal cuali-cuantitativo para determinar realmente la riqueza forestal argentina. Encarará además la defensa, mejoramiento y ampliación de los bosques del Estado; el estudio de las maderas indígenas y exóticas para darle a cada una la aplicación que mejor responda según sus características.

La defensa de los bosques la realizará organizando un servicio de prevención y lucha contra incendios, que año tras año ocasionan extraordinarias devastaciones, especialmente en los bosques de la mitad norte de la región subantártica. Con igual fin de defensa y mejoramiento se aumentarán y racionalizarán las explotaciones de los bosques y su administración, coordinándose el pastoreo de la hacienda en el interior de los macizos arbóreos.

Mediante planes técnicos de reforestación se encarará el mejoramiento en vasta escala de los bosques degradados, que suman una gran parte del área boscosa del país.

La ampliación del área forestal sobre suelos inadecuados para hacer agricultura, como son los de la región seca, será, sin duda, la labor más árdua que deberá encarar la Dirección Forestal.

El plan de trabajos se completará con el estudio de las características botánicas de las especies arbóreas indígenas que pasan de 1000 y de las exóticas aclimatadas y naturalizadas, que también son muy numerosas, realizándose, además, el estudio xilológico y tecnológico completo de las mismas. De tal manera se podrá dar a cada madera la aplicación que más convenga de acuerdo a sus características.

Las funciones y deberes de la Dirección Forestal, son las siguientes.

(1) Controlar las explotaciones y ejercer la vigilancia de los bosques fiscales, así como también todo lo rela-

cionado con el movimiento de extracciones, recaudación por aforos y nuevas concesiones que se acuerden. A este efecto tendrá las atribuciones que acordaba a la Dirección de Tierras el Régimen Forestal vigente.'

(2) Efectuar los inventarios forestales cuali-cuantitativos que permitan la preparación del Mapa Forestal de los Bosques del Estado. Mientras tanto tendrá jurisdicción directa sobre las superficies de tierras fiscales cubiertas por bosques y sobre las de aptitud forestal, que se encuentren libres de adjudicación de venta, ya sea en zonas agrícolas o pastoriles.

(3) Propender a la explotación racional de los bosques del Estado.

(4) Tomar las medidas tendientes a prevenir y luchar contra los incendios de bosques.

(5) Reglamentar el pastoreo de haciendas en los bosques o tierras forestales de propiedad fiscal.

(6) Realizar la reforestación mejoradora de los bosques del Estado y ampliar la superficie boscosa actual, sobre tierras de aptitud forestal.

(7) Realizar estudios de maderas para dar a cada una la aplicación que más convenga.

(8) Promover nuevas industrias forestales y realizar la labor de asesoramiento y orientación en este sentido.

(9) Realizar la coordinación de los estudios forestales y la centralización de informaciones, organizando además museos, exposiciones, conferencias, cursos y publicaciones científicas y de divulgación.

(10) Coordinar sus actividades con los servicios pertinentes del Departamento de Agricultura y con otras Instituciones Oficiales, para la mejor solución de los problemas forestales.

(11) Proyectar las modificaciones del Régimen Forestal vigente.

La Dirección Forestal cuenta con un presupuesto anual amplio y el personal técnico y administrativo que permitirá ir cumpliendo metodicamente el plan propuesto.

Aparte de la Dirección Forestal, la Dirección de Parques Nacionales y Turismo, organismo dependiente también del Ministerio de Agricultura de la Nación, encargado de fomentar el mejor y mayor conocimiento del país, posee una Sección de Tierras y Bosques que incluye un servicio forestal para los Parques Nacionales.

Fuera de ellas, se hacen investigaciones forestales, especialmente de Laboratorio, en el Instituto de Silvicultura de la Facultad de Agronomía y Veterinaria de la Universidad de Buenos Aires.

*Reforestación.*—Nuestro país, así como todos los de Sudamérica, ha sufrido mucho por el progresivo y rápido proceso de deforestación de los bosques naturales.

Antiguas formaciones densas, son hoy parques naturales, matorrales, estepas y hasta verdaderos desiertos, debido a la acción constante y negativa del factor antropógeno.

En este sentido los incendios originados por el hombre, son los que más perjuicios han ocasionado sobre todo en los bosques subantárticos desde Neuquén hasta Chubut.

Aparte de ello, otros factores concurrentes a la disminución y degradación de los bosques argentinos son la explotación irracional de los macizos y el pastoreo continuado de la hacienda en el interior de los bosques.

En la mayor parte de los casos la acción pronunciadamente negativa de estos factores determinará mayores esfuerzos para encarar la reforestación. Por esta razón se están realizando estudios sobre experiencias efectuadas en el país y en este sentido hemos llegado a la conclusión que sobre aclimatación y naturalización de especies arbóreas, existen en la Argentina muchos trabajos, que denotan el esfuerzo realizado, preferentemente por particulares. Muchos de ellos constituyen importantes realidades y han de ser muy útiles para el plan de reforestación racional del país.

Por ejemplo hoy sabemos que, en regiones muy pobres, como son las del Bosque pampeano, se comportan bien, sin riego, *Pinus halepensis, P. pinea, P. pinaster, Cupressus arizonica, C. sempervirens,* aparte de varias especies de *Eucalyptus* como *E. viminalis, E. rostrata* y *E. tereticornis* que poseen además muy buena madera.

La comprobación de estos hechos, es de gran importancia para el territorio de La Pampa por ejemplo, donde la abusiva e irracional explotación de *Prosopis caldenia* y *Prosopis alba,* ha originado modificaciones profundas del medio primitivo creando extensas estepas graminosas en unos casos y campos volados o médanos en otros. Por estas razones la regeneración natural de las dos especies de *Prosopis* citadas, se halla bastante reducida y en algunos lugares, ya no existe. Resultará por ello ventajosa la implantación de las especies exóticas citadas que al par que proporcionan buena madera, permitirán la vuelta al estado boscoso primitivo. Claro está que pensamos también, que la reforestación con *Prosopis,* sobre todo con *P. alba,* habrá de auxiliarnos en la obra de reforestación, proporcionándonos además madera dura y de óptima calidad.

En las regiones en que a pesar de la devastación realizada desde hace muchos años, el ambiente forestal se conserva aún, la reforestación no presentará dificultad, hallándose en esta situación la máxima parte de los bosques decrépitos de la región subantártica.

En Esquel (Chubut) por ejemplo, el desarrollo del spruce (*Picea alba* y *P. excelsa*) es semejante al que viéramos en la región escandinava (Finlandia y Suecia), puesto que muchos ejemplares presentaban un incremento longitudinal anual hasta de 80 cm, durante los 5 primeros años. Si se piensa que esta especie era la que en época normal, suministraba la mayor parte de la pasta química para papel de diarios que se consume en el mundo y que, además, es la mejor madera para la fabricación de instrumentos musicales, nos percataremos de la importancia de su cultivo en la República Argentina.

Se podría entonces encarar el rejuvenecimiento de aquellos bosques, decrépitos en su mayor parte, mediante la plantación de coníferas, que como la ya citada son indicadas para dicha region fría y templada fría y las que más se destacan por su valor económico.

En el Vivero de la Dirección Forestal en San Martín de los Andes (Neuquén), se puede apreciar el gran desarrollo que adquiere otra importante conífera europea, *Pinus silvestris,* plantada en las abras y en los bosques claros y muy degradados de la región, donde el *Libocedrus chilensis,* que es la especie indígena, prospera poco.

En el Delta del río Paraná, que es la única región del país en que hasta el presente se ha hecho Silvicultura en cierta escala, está muy difundido el álamo criollo (*Populus nigra,* var. *italica*), sauce álamo (*Salix alba,* var. *coerulea*) y el álamo híbrido italiano A.M. (*Populus nigra,* var. *stella* × *P. canadensis*). También existen plantaciones importantes de ciprés calvo

(*Taxodium distichum*) y de pino de Monterey (*Pinus radiata*). En los últimos años la difusión alcanzada por el híbrido italiano A.M. en el Delta del río Paraná fué extraordinaria; ello se debió a que el álamo criollo que era el más común fué fuertemente atacado por varias royas y rápidamente los pobladores isleños realizaron su sustitución por el citado híbrido que parece ser muy resistente a dicha enfermedad.

Otra especie dicotiledónea europea de gran porvenir y valor económico es el roble europeo (*Quercus pedunculata*), cuya madera se presta para numerosas aplicaciones y cuyo cultivo en gran escala es preciso encarar dada la facilidad con que se dá en la provincia de Buenos Aires. En Chapadmalal, cerca de Mar del Plata (sureste de la provincia de Buenos Aires) esta especie se regenera naturalmente y su vitalidad es tal, que debajo de árboles porta-granos se pueden contar hasta 120 plántulas por metro cuadrado.

Aparte de las especies que hemos citado crecen muy bien en dicha región y en los alrededores de la Capital Federal: *Fraxinus excelsior, Quercus palustris, Grevillea robusta, Ulmus campestris, Platanus orientalis, Robinia pseudacacia, Ailanthus glandulosa, Liriodendron tulipifera, Melia azedarach, Araucaria bidwillii, Pinus taeda, P. echinata, P. caribea.*

En distintos lugares de los bosques subantárticos (San Martín de los Andes, Nahuel-Huapí) crecen bien *Larix europea, Betula alba* y *B. verrucosa*. En la región subtropical tucumano—boliviana, la *Swietenia mahagoni, Tectona grandis, Bambusa arundinacea, B. vulgaris,* etc.

En lo que respecta a la reforestación con especies indígenas, las observaciones que consideramos más interesantes son las que se refieren a *Araucaria angustifolia*. En efecto, existe en colonia Eldorado (Misiones) una plantación de 3.000 araucarias que a los 7 años presentaban un diámetro medio de 25 cm y una altura media de 11 m. Un crecimiento tan rápido, reviste para nuestro país capital importancia, si se tiene en cuenta la perfecta aptitud de la madera de esta especie para la fabricación de celulosa para papel de diarios.

En el *Ingenio ledesma* (Jujuy) existen también importantes experiencias sobre reforestación con *Piptadenia macrocarpa, Torresea cearensis, Cedrela lilloi, Enterolobium contortisiliquum, Jacaranda acutifolia, Pterogyne nitens, Tabebuia ipe,* todas ellas especies indígenas de gran importancia económica.

En la Isla Victoria, del Lago Nahuel-Huapí (Neuquén) el vivero de la Dirección de Parques Nacionales y Turismo, lleva realizados importantes trabajos de reforestación y lo mismo puede decirse de los viveros de la Dirección Forestal ubicados en Presidente de la Plaza (Chaco) y Caá-Guazú (Misiones) etc.

*Forestación.*—La región pampeana, vasto territorio apróximadamente de 500.000 km$^2$ está desprovisto de árboles. Sin embargo, si se los cuida sobre todo durante la primera edad estos crecen bastante bien. Hay especies como el paraíso; acacia negra (*Gleditschia triacanthus*), a. blanca (*Robinia pseudacacia*), *Eucalyptus* spp., casuarina (*Casuarina cunninghamiana*), que crecen rápidamente en este suelo, alcanzando respetable desarrollo en pocos años. Tales especies podrían tener aquí un gran porvenir como madera de obra y combustible.

Siendo una región sin combustibles naturales, consideramos que nada existe más ventajoso para enriquecer esta región que el cultivo de árboles que podrían plantarse en cercos, en macizos, a lo largo de los caminos o rodeando las habitaciones. La conservación de estas plantaciones repercutiría evitando los efectos de los fuèrtes vientos y serviría de reparo a la hacienda, evitando además la acción de la erosión.

Los propietarios aumentarían notablemente el valor de sus campos, si hicieran plantaciones de árboles en escala no inferior al 3% de la superficie.

*Industria del Extracto de quebracho.*—La Argentina era antes de la guerra un fuerte exportador de rollizos de quebracho colorado y de extracto de quebracho. En el año 1939 exportó 195.863 toneladas de tanino y 74.948 toneladas de rollizos, lo que equivale apróximadamente a $ 50.000.000 m/n.

Según hemos referido, las propiedades curtientes del quebracho colorado chaqueño (*Schinopsis balansae*) y el quebracho santiagueño (*Schinopsis lorentzii*) se conocen desde 1850.

Sin embargo la madera que más se emplea es de *Schinopsis balansae*, cuyo durámen proporciona alrededor de 33 por ciento de extracto de quebracho con 63 por ciento de tanino puro.

*Schinopsis lorentzii* no se utilizaba hasta hace poco tiempo debido a que, teniendo alrededor de 18 por ciento de extracto de quebracho con 58 por ciento de tanino puro, exigía un consumo mayor de madera y por lo tanto encarecía el costo del extracto. Ultimamente, debido a la disminución acelerada de *Schinopsis balansae* en los bosques de la formación chaqueña, algunas fábricas de extracto han utilizado también esta especie; igual cosa hicieron, aunque en pequeña escala con la madera de *Astronium balansae*, que proporciona menos extracto que *Schinopsis lorentzii* pero, según parece, de muy buena calidad.

El proceso de elaboración del extracto consta de tres etapas: *1.* Los rollizos (es decir el tronco) y las ramas gruesas descortezados y sin albura, van a la trituradora que lo transforma en aserrín para facilitar su extracción o difusión. Esta operación se efectúa en 8 grandes difusores de cobre.—*2.* El líquido de los difusores, se deposita en grandes tinas, de donde se mandan a los evaporizadores para que se concentre, sometido a la acción de temperatura y vacío.—*3.* Cuando se observa que el extracto tiene la concentración deseada y aún caliente y pastoso, se lo hecha en bolsas que se depositan en lugar ventilado y a la sombra, tardando unas 24 horas en endurecerse. Las bolsas de extracto de quebracho pesan 50 kg.

Cuando los rollizos están descortezados y sin albura, se hace muy difícil distinguir a simple vista las 2 especies citadas del género *Schinopsis*. Sólo se diferencia y con bastante práctica, bajo el microscopio.

En cuanto al árbol se diferencia porque *Schinopsis balansae* tiene hojas simples mientras que *Schinopsis lorentzii* tiene hojas compuestas.

*Schinopsis balansae*, por su gran importancia económica, es una de las especies que más ha sido afectada por la explotación irracional. Un

cálculo aproximado, indica que de seguir explotándolo en la forma que se hacía últimamente, habría desaparecido antes de 50 años.

*Industria del Carbón Vegetal.*—El carbón vegetal o residuo de la combustión incompleta de la leña, obtenida por limitación del acceso de aire, se fabrica en nuestro país por el primitivo método de las carboneras de tierra.

Se producen apróximadamente unas 775.000 toneladas en todo el país, correspondiendo a las provincias de Córdoba, Santiago del Estero y Catamarca, la mayor producción.

La especie arbórea más utilizada es el quebracho blanco (*Aspidosperma quebracho blanco*) siguiéndole el algarrobo negro (*Prosopis nigra*), algarrobo blanco (*P. alba*), ñandubay (*P. algarrobilla* var. *ñandubay*), quebracho santiagueño (*Schinopsis lorentzii*), mistol (*Zizyphus mistol*), chañar (*Gourliea spinosa*), tororataí (*Tabebuia nodosa*), brea (*Cercidium praecox*). El quebracho blanco y algarrobo negro se utilizan solos, mientras que los demás se mezclan.

El proceso de elaboración en las carboneras de tierra comprende las siguientes operaciones: *a*) corte; *b*) rodeo; *c*) apilado en el bosque; *d*) construcción del horno: *1*) armar, *2*) tapar*; *e*) carbonización; *f*) enfriado y extracción. La carbonización se realiza del centro a la periferia y de arriba abajo y puede durar de 25 a 32 días según la capacidad del horno.

Este sistema de carbonización tan primitivo rinde de 12 a 15, 7 por ciento es decir, que para obtener una tonelada de carbón se necesitan normalmente diez metros lineales de leña o sea, tratándose de quebracho blanco que es el más usado, 7 toneladas de leña para obtener una tonelada de carbón.

El carbón de quebracho blanco es el de mejor calidad puesto que no chisporrotea, es fuerte, arde lentamente y no da mucha ceniza. Sin embargo, es lamentable que debido al aprovechamiento total de los árboles destinados a esta industria, el porvenir de las especies arbóreas utilizadas y muy especialmente el quebracho blanco se vea actualmente muy comprometido, ya que aún no se ha encarado la reforestación con dicha especie, y se desconoce casi totalmente su biología.

Por otra parte resulta sin duda lamentable, el hecho que ejemplares de quebracho blanco de todos los diámetros, desde los jóvenes pertigales hasta los más añosos veteranos (seedling, sapling, poles, standards and veterans), sean utilizados para hacer carbón. Y esta situación resulta más alarmante si se tiene en cuenta que también van a los hornos de carbón, hermosos rollizos hasta de 6 m de alto por 60 cm de diámetro, cuya madera, por sus excelentes caracteres, podría ser usada mucho más ventajosamente para otros fines.

El conocimiento futuro de la biología de especies arbóreas indígenas y exóticas, nos permitirá aplicar y difundir el tratamiento forestal denominado bajo tallar, que es el más apropiado desde todo punto de vista, para ser aplicado en las masas destinadas a la fabricación de carbón. Claro está que para ello será imprescindible que, paralelamente, se perfeccionen los sistemas de carbonización utilizados en la actualidad.

* Estos hornos son de 15 a 20 m de base por 5 a 6 m de alto; la capacidad oscila entre 170, 300, y 500 m.

*Otras industrias.* — A raíz de las dificultades creadas por la guerra se han iniciado exitosamente o han tomado diversas industrias madereras.

La última Exposición Forestal realizada en la Capital Federal durante los meses de Enero a Abril de 1943, demostró claramente las extraordinarias posibilidades de la Argentina en este aspecto industrial. En tal sentido citaremos algunas de las que más se destacaron a saber:

Aviones de: *Cedrela fissilis*, var. *macrocarpa*, *Araucaria angustifolia*.

Coches y vagones de ferrocarril de: *Torresea cearensis*, *Tipuana tipu*, *Cabralea oblongifoliola*, *Pterogyne nitens*, *Aspidosperma quebracho-blanco*.

Construcciones navales de: *Patagonula americana*, *Myrocarpus frondosus*, *Tabebuia ipe*, *Pithecolobium tortum*, *Nectandra* spp., *Astronium balansae*, *Pterogyne nitens*, *Fitzroya cupressoides*, *Libocedrus chilensis*, *Nothofagus betuloides*, *N. dombeyi*, *N. pumilio*, *N. obliqua*.

Duelas para cascos de vino de: *Prosopis* spp., *Prosopis caldenia*, *Patagonula americana*, *Phyllostylon rhamnoides*, *Cordia trichotoma*, *Nothofagus dombeyi*, *N. betuloides*, *N. pumilio*.

Cajones de: *Sapium haematospermum*, *Araucaria angustifolia*, *Salix humboldtiana*, *Enterolobium contortisiliquum*, *Nothofagus procera*, *Chorisia speciosa*.

Carpintería: *Prosopis* spp., *Prosopis caldenia*, *Cedrela lilloi* y *C. fissilis*, var. *macrocarpa*, *Piptadenia macrocarpa*, *Patagonula americana*, *Peltophorum dubium*, *Myrocarpus frondosus*, *Ocotea* sp., *Chlorophora tinctoria*, *Cordia trichotoma*, *Araucaria angustifolia*, *Torresea cearensis*, *Pithecolobium tortum*, *Enterolobium contortisiliquum*, *Tipuana tipu*, *Fitzroya cupressoides*, *Libocedrus chilensis*, *Nothofagus dombeyi*, *N. betuloides*, *N. pumilio*, *N. procera*, *N. obliqua*, *Araucaria angustifolia*.

Carretería, carrocería de: *Prosopis* spp., *Balfourodendron riedelianum*, *Patagonula americana*, *Peltophorum dubium*, *Myrocarpus frondosus*, *Tabebuia* spp., *Ocotea* sp., *Nectandra* sp., *Aspidosperma quebracho-blanco*, *Cordia trichotoma*, *Tipuana tipu*, *Pterogyne nitens*, *Nothofagus obliqua*.

Construcciones civiles de: *Prosopis* spp., *Cabralea oblongifoliola*, *Copernicia australis*, *Piptadenia macrocarpa*, *Balfourodendron riedelianum*, *Apuleia leiocarpa*, *Peltophorun dubium*, *Myrocarpus frondosus*, *Nectandra* spp., *Ocotea* spp., *Calycophyllum multiflorum*, *Cordia trichotoma*, *Aspidosperma quebracho-blanco*, *Pithecolobium tortum*, *Enterolobium contortisiliquum*, *Astronium balansae*, *Pterogyne nitens*, *Fitzroya cupressoides*, *Libocedrus chilensis*, *Nothofagus dombeyi*, *N. betuloides*, *N. pumilio*, *N. procera*, *N. obliqua*.

Durmientes de: *Prosopis* spp., *Piptadenia macrocarpa*, *Caesalpinia melanocarpa*, *Schinopsis lorentzii*, *Schinopsis balansae*, *Nothofagus dombeyi*.

Ebanistería, mueblería de lujo de: *Prosopis* spp., *Cabralea oblongifoliola*, *Cedrela lilloi* y *C. fissilis* var. *macrocarpa*, *Piptadenia macrocarpa*, *Gleditschia amorphoides*, *Caesalpinia melanocarpa*, *Patagonula americana*, *Apuleia leiocarpa*, *Peltophorum dubium*, *Mycocarpus frondosus*, *Tabebuia* spp., *Ocotea* sp., *Chlorophora tinctoria*, *Juglans australis*, *Calycophyllum multiflorum*, *Aspidosperma peroba*, *Bulnesia sarmienti*, *Cordia trichotoma*, *Araucaria angustifolia*, *Torresea cearensis*, *Pithecolobium tortum*, *Enterolobium contortisiliquum*, *Astronium balansae*, *Pterogyne nitens*, *Fitzroya cupressoides*, *Libocedrus chilensis*, *Nothofagus dombeyi*, *N. procera*.

Hormas para zapatos de: *Prosopis alba*, *Aspidosperma quebracho-blanco*, *Nothofagus betuloides*, *Luehea divaricata*.

Marcos de puertas y ventanas de: *Prosopis caldenia*, *Cedrela lilloi*, *C. fissilis*, var. *macrocarpa*, *Patagonula americana*, *Peltophorum dubium*, *Myrocarpus frondosus*, *Tecoma* spp., *Enterolobium contortisiliquum*, *Pterogyne nitens*, *Fitzroya cupressoides*, *Libocedrus chilensis*, *N. pumilio*, *N. procera*, *N. obliqua*.

Pasta de papel de: *Araucaria angustifolia*, *Araucaria araucana*, *Podocarpus parlatorei*, *Nothofagus dombeyi*, *N. betuloides*, *N. pumilio*.

Placas y enchapados para ebanistería de: *Cedrela lilloi*, *C. fissilis* var. *macrocarpa*, *Juglans australis*, *Araucaria angustifolia*, *Torresea cearensis*, *Nothofagus betuloides*, *N. pumilio*, *Araucaria araucana*, *Jacaranda acutifolia*.

Parquets de: *Prosopis alba, Prosopis caldenia, Patagonula americana, Juglans australis, Calycophyllum multiflorum, Aspidosperma quebracho-blanco.*

Postes de teléfono y telégrafo de: *Copernicia australis, Calycophyllum multiflorum, Araucaria angustifolia, Schinopsis balansae, Schinopsis lorentzii, Astronium balansae, Libocedrus chilensis, Nothofagus pumilio, Araucaria angustifolia, Araucaria araucana.*

Puentes, obras hidráulicas, malecones, pilotes, tajamares, construcciones a la intemperie, etc. de: *Piptadenia macrocarpa, Caesalpinia melanocarpa, Tecoma* spp., *Schinopsis balansae, Schinopsis lorentzii, Astronium balansae, Fitzroya cupressoides.*

Tablas, tablones, vigas de: *Cabralea oblongifoliola, Copernicia australis, Cedrela lilloi, C. fissilis* var. *macrocarpa, Gleditschia amorphoides, Balfourodendron riedelianum, Patagonula americana, Apuleia leiocarpa, Peltophorum dubium, Araucaria angustifolia, Luehea divaricata, Enterolobium contortisiliquum, Astronium balansae, Fitzroya cupressoides, Nothofagus betuloides, Nothofagus pumilio, Araucaria araucana, Nothofagus procera, Nothofagus obliqua.*

Extracto de quebracho y extracto de tanino de: *Schinopsis balansae, Schinopsis lorentzii, Caesalpinia melanocarpa, Prosopis, Astronium balansae, Piptadenia macrocarpa, Enterolobium contortisiliquum.*

Tarugos para pavimentos de calles de: *Prosopis alba, Prosopis nigra, Prosopis caldenia, Patagonula americana.*

Tejuelas de: *Apuleia leiocarpa, Myrocarpus frondosus, Araucaria angustifolia, Luehea divaricata, Enterolobium contortisiliquum, Fitzroya cupressoides.*

Maderas compensadas de: *Juglans australis, Calycophyllum multiflorum, Araucaria angustifolia, Araucaria araucana, Nothofagus dombeyi, Nothofagus betuloides, Nothofagus pumilio, Jacaranda acutifolia, Gleditschia amorphoides.*

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BUENOS AIRES, ARGENTINA.

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JUAN B. MARCHIONATTO: **Las Enfermedades de las Plantas Cultivadas de la Argentina y sus Problemas:** — Las enfermedades de las plantas cultivadas en la R. Argentina, que tienen importancia económica, son registradas por primera vez en la obra de C. D. GIROLA, "Investigación agrícola en la República Argentina" (An. Min. Agric., I:217-238, 1904), al hacerlas constar en los trabajos hechos por diversos técnicos del Ministerio de Agricultura para dar a conocer los problemas regionales de la agricultura argentina.

Sin embargo, la verdadera fuente de información del estado de nuestros conocimientos sobre esta materia se revela, diez años más tarde, cuando aparece la publicación de L. HAUMAN MERCK "Les parasites végétaux des plantes cultivées en Argentine et dans les régions limitrophes" (An. Mus. Hist. Nat. de Bs. Aires, XXVI: 163-225, 1914), donde, con método científico, se catalogan los parásitos vegetales, criptogámicos y fanerogámicos, de las plantas económicas y cultivadas, especialmente, en la R. Argentina.

Fué este mismo autor quien hizo más tarde, en colaboración con L. R. PARODI, una ampliación de su catálogo, que se publicó bajo el título de "Los parásitos vegetales de las plantas cultivadas de la República Argentina" (Rev. Fac. Agr. y Vet. de Bs. Aires, III:227-274, 1921) y en donde se anotan la mayor parte de las enfermedades de origen parasitario existentes en el país, con breves datos sobre su distribución geográfica, síntomas, perjuicios y sus antecedentes bibliográficos. En esta publicación ya se plantean diversos problemas fitopatológicos relacionados con la etiología, patogenia y control de muchas de las enfermedades registradas, cuyas lagunas se ha tratado de llenar desde entonces, y especialmente en estos últimos diez años, a raíz de haberse organizado definitivamente los servicios de investigación de la Dirección de Sanidad Vegetal del Ministerio de Agricultura de la Nación.

A continuación hacemos una ligera reseña de las enfermedades principales de los cereales, que son las plantas de mayor importancia económica de la Argentina, y sus problemas.

Tres royas atacan al trigo y producen graves perjuicios en los años favorables a su desarrollo. La "roya anaranjada" (*Puccinia triticina* Erik.) fué la primera que llamó la atención del fitotécnico por su aparición constante, en el norte de la región triguera (Córdoba), sobre las viejas poblaciones de trigo Barletta, llegando a disminuir sus rendimientos en un 20%.

BACKHOUSE resolvió este problema con la obtención del híbrido 38 M.A., resistente a la enfermedad. Posteriormente otros trigos argentinos (Sinvalocho M.A., etc.), con las mismas características, completaron esta acción, que deberá mantenerse así orientada para evitar en el futuro cualquier sorpresa.

Por otra parte, la eliminación de los cultivos de los trigos muy susceptibles a la "roya anaranjada" es una medida de previsión necesaria, y es lo que está sucediendo últimamente con la variedad Lin Calel M.A., que entre otros defectos tenía el de ser muy atacada por la *P. triticina.*

La "roya negra" (*Puccinia graminis tritici* Erik.) y la "roya amarilla" (*P. glumarum* Erik.) son las que han producido hasta el presente los mayores daños, por aparecer, en los años favorables, con caracteres epifíticos. La "roya negra" domina en la región húmeda, mientras que la "roya amarilla" lo hace en la parte central de la región triguera, donde el clima es más frío.

Contra la "roya negra" no poseemos aún trigos resistentes, pero sí variedades precoces, cuyos cultivos dominan en la región húmeda y que escapan así a la enfermedad, la que se manifiesta tardíamente.

La "roya amarilla" hace relativamente pocos años (1929) que hizo su aparición en el país, pero con tanta virulencia que provocó el abandono del trigo Record, una de las variedades más cultivadas en esa época. Actualmente contamos con algunas variedades (Klein Acero, etc.) que

tienen cierta resistencia al parásito, y los trabajos de fitotécnica se orientan en este sentido.

El problema de la producción de epifitias por estas royas no se descarta, pues la Argentina limita con otros países (Uruguay, etc.) que cultivan intensamente trigo, y con los que puede producirse un intercambio natural de las poblaciones de sus royas, en forma análoga a lo que sucede en otras partes del mundo.

La solución permanente del problema ya ha sido encarado por el Instituto Fitotécnico de Santa Catalina, que cuenta con una sección especializada en trabajos de inmunología de royas y que mantiene una estrecha colaboración con los especialistas que tienen a su cargo la misma tarea en ambas Américas.

Las "caries" (*Tilletia tritici* (Bjerk.) Wint. y *T. laevis* Kühn.) son enfermedades generalizadas en la región triguera, aunque dominan en las partes semi-áridas (sur de Córdoba y Santa Fe, sudoeste de la provincia de Buenos Aires y territorio de La Pampa). La lucha contra ambas enfermedades no ofrece mayor dificultad, habiéndose generalizado en estos últimos años el tratamiento de los granos por los métodos "secos."

El "carbón volador" (*Ustilago tritici* (Pers.) Rostr.), aunque no tiene la importancia de las caries, preocupa porque no se puede aconsejar al agricultor la desinfección del grano por el "agua caliente," procedimiento eficaz pero que sólo lo practican aquellos criaderos y multiplicadores de semilla de "pedigree" que poseen instalaciones adecuadas.

La solución de este problema también está en el empleo de variedades resistentes, tales como el 38 M.A., y en ir eliminando de los cultivos las muy susceptibles, como pasó, en estos últimos años, con los trigos Sin Rival y Vencedor.

Diversos "pietines" atacan al trigo, pero sobre todo los provocados por el *Ophiobolus graminis* Sacc. y el *Helminthosporium sativum* P.K.B. son los más perjudiciales, y que se encuentran radicados en la región triguera semi-árida. Los daños mayores se observan en las plantas pequeñas, y en los años muy húmedos los "manchones" alcanzan grandes extensiones y preocupan al agricultor.

Para combatir estas enfermedades se recomienda especialmente la rotación de los cultivos con otras plantas (avena, etc.). Pero como esta práctica cultural es un elemento auxiliar y no se alcanza erradicar a estos parásitos, parecería, como ya se ha vislumbrado por algunos autores, que debe buscarse la solución por otra vía, como sería estudiando las especies antagónicas de los hongos que producen los pietines, y cuya aplicación ya se ha demostrado para otros microorganismos.

El "carbón" (*Ustilago zeae* (Beck.) Ung.) es la enfermedad más común del maíz, pero sus manifestaciones son esporádicas, pues la mayor parte de las variedades que cultivamos la resisten. Sin embargo, como el procedimiento de lucha contra esta enfermedad, consistente en erradicar las plantas atacadas, no es práctico, deberá perseverarse en la selección de maíces resistentes.

El "carbón cubierto" (*Ustilago hordei* (Pers.) K. et S.) y el "Carbón desnudo" (*U. nuda* (Jens.) K. et S.) de la cebada se presentan con cierta frecuencia en los cultivos, aunque prepondera el nombrado en primer término.

Para el control de ambas enfermedades nos remitimos a lo dicho al considerar las caries y el carbón volador del trigo, desde que los tratamientos de lucha, como se sabe, son análogos.

La helmintosporiosis (*Helminthosporium teres* Sacc.) es la enfermedad más común de la cebada, y bastante perjudicial, a pesar de que también puede ser atacada por el *H. sativum* P.K.B. y el *H. gramineum* Rabenhorst.

La lucha contra la helmintosporiosis se desconoce, pero comportándose el *H. teres* como un parásito específico, la obtención de plantas resistentes sería la más aconsejable.

La "roya amarilla" (*Puccinia coronata* Cda.) de la avena es la enfermedad más importante, pues las variedades que cultivamos son muy susceptibles, y la roya (*Puccinia dispersa* Erik.) del centeno es también común, pero sus daños no son graves.

La lucha contra estas royas se orienta hacia la producción de variedades resistentes y, especialmente en la avena, los trabajos se encuentran adelantados.

Finalmente anotamos la "quemadura" (*Piricularia oryzae* Br. et Cav.) del arroz, que aunque de reciente data en el país, se ha presentado con carácter virulento en la región arrocera del Norte (Salta y Tucumán) y preocupa a los cultivadores.

El control de esta enfermedad se desconoce, pero por sus características la solución estaría en seleccionar variedades resistentes.

*LOS SERVICIOS DE FITOPATOLOGIA EN LA REPUBLICA ARGENTINA:* — Los servicios oficiales de investigaciones sobre fitopatología en la República Argentina de la Nación por intermedio de la Dirección de los realizan, en primer lugar el Ministerio de Agricultura Sanidad Vegetal, las Universidades Nacionales de Buenos Aires y La Plata por sus Facultades de Agronomía, y los Gobiernos Provinciales de Buenos Aires, Santa Fe y Tucumán por intermedio de la Dirección de Agricultura e Industrias, del Instituto Experimental y Fomento Agrícola-Ganadero, y de la Estación Experimental Agrícola, respectivamente.

La Dirección de Sanidad Vegetal para el estudio de las enfermedades de las plantas y su control, cuenta con los servicios siguientes: División de Fitopatología, en la ciudad de Buenos Aires (Capital Federal), con sus laboratorios de Bacteriología, Micología y Virología, la Estación de Cuarentena de Plantas, de José C. Paz (prov. de Buenos Aires) y los laboratorios de Fitopatología de Campana (isla del Delta), de Bella Vista (provincia de Corrientes), de Resistencia (Territorio Nacional del Chaco), de Salta (provincia de Salta), de Mendoza (provincia de Mendoza), de Alto de Sierra (provincia de San Juan), de Córdoba (provincia de Córdoba) y de Coronel Juan F. Gómez (Territorio Nacional de Río Negro).

La División de Fitopatología tiene a su cargo especialmente, el estudio de las enfermedades de las plantas que aparecen en todas aquellas regiones del país que no poseen servicios de investigación de orden nacional, y los ensayos de los productos fungicidas que se encuentran en venta en el comercio, contando para esto último, con la ayuda de los laboratorios de Fitopatología regionales, citados más arriba.

La Estación de Cuarantena de Plantas, que se halla situada a 40 kilómetros de la Capital Federal, además de destinarse para mantener bajo observación las plantas y semillas que se importan, sirve de campo experimental para los trabajos que realiza la División de Fitopatología.

El laboratorio de Fitopatología de Campana, que funciona en el Vivero Nacional, se especializa en las enfermedades de los frutales (duraznero, ciruelo, manzano, etc.) y árboles forestales (álamos y sauces); el laboratorio de Fitopatología de Bella Vista, que funciona en el Vivero Nacional, en las enfermedades de los citrus; y el laboratorio de Fitopatología de Cnel. Juan F. Gómez, que funciona en la Estación Experimental, en las enfermedades de los frutales (peral, manzano, etc.).

El laboratorio de Fitopatología de Salta, en las enfermedades de las plantas hortícolas (pimiento, tomate y papa) y el tabaco; el laboratorio de Fitopatología de Mendoza, que funciona en el Instituto Agronómico de la Universidad Nacional de Cuyo y el laboratorio de Alto de Sierra, que funciona en la Estación Experimental, se especializan en las enfermedades de los

frutales (vid, manzano, nogal, etc.) y de las plantas hortícolas (pimiento y tomate).

El laboratorio de Fitopatología de Córdoba, que funciona en la Escuela Nacional de Agricultura, se especializa en las enfermedades de los frutales (duráznero, nogal, etc.) y cereales, y el laboratorio de Fitopatología de Resistencia, en las enfermedades del algodonero.

Los laboratorios de Fitopatología de las Universidades Nacionales de Buenos Aires y La Plata, se encuentran anexados a las cátedras de esta materia y funcionan, respectivamente, en la Facultad de Agronomía y Veterinaria de Buenos Aires (Villa Ortúzar), y en la Facultad de Agronomía de La Plata. De esta última, depende, además, el Instituto Fitotécnico de Santa Catalina, ubicado en Llavallol (prov. de Buenos Aires), donde se hacen los trabajos de inmunología a las royas de los cereales y plantas forrajeras.

El laboratorio de Fitopatología dependiente de la Dirección de Agricultura e Industrias de la provincia de Buenos Aires, es, esencialmente, un laboratorio de diagnóstico de las enfermedades de los cultivos de la provincia, y lo mismo sucede con el laboratorio de Fitopatología, dependiente del Instituto Experimental y Fomento Agrícola de Santa Fe; mientras que el laboratorio de Fitopatología de la Estación Experimental Agrícola de Tucumán está especializado en las investigaciones sobre las enfermedades de la caña de azúcar y otras plantas subtropicales (citrus, tabaco, algodón, etc.).

DIRECCIÓN DE SANIDAD VEGETAL,
MINISTERIO DE AGRICULTURA DE LA NACIÓN,
BUENOS AIRES, ARGENTINA.

BERNARDO ROSENGURTT GURVICH: **La Vegetación del Uruguay**: — Región de los campos uruguayos es la denominación geobotánica que elegimos para nuestro país. Es una prolongación de los campos austrobrasileros pero existen además influencias florísticas de la pradera pampeana, y del parque mesopotámico en el Oeste.

En el Uruguay se distinguen dos zonas: el Sur, de antíguo origen volcánico, recubierto por el limo pampeano en gran parte, y aflorando con frecuencia roquedales graníticos; la zona Norte está formada de areniscas Gondwánicas, más o menos coherentes, de origen sedimentario reciente.

En la región de los campos uruguayos predominan completamente las praderas, y despues del hombre, el ganado es el factor ecológico preponderante desde hace 3 siglos. El área cultivada y poblada suma un 10%.

Las formaciones más importantes son: la pradera, los bosquecillos, los bañados, las sierras, los arenales marítimos y los palmares.

La pradera es ondulada en todo el país y se hallan frecuentemente, rocas esparcidas. En la zona Sur predomina la asociación *Stipa-Paspalum-Piptochaetium*. *Stipa charruana* es la especie característica, imprime un aspecto particular a estos campos, por sus densas matas fasciculadas. *Paspalum quadrifarium* tambien forma grandes matas fasciculadas, pero es menos abundante. *Piptochaetium panicoides, P. ovatum*, etc. abundan en el tapiz bajo. En la zona Norte domina la asociación *Andropogon-Paspalum*. *Andropogon condensatus, A. lateralis incanus* y *Paspalum quadrifarium* son las gramíneas altas y fasciculadas que se destacan sobre el tapiz formado principalmente de *Paspalum notatum*. *Andropogon tener, Heteropogon villosus* y *Tridens brasiliensis* son comunes en el Norte y raras en el Sur.

Otros pastos abundantes en los campos uruguayos son *Paspalum dilatatum* forrajera muy conceptuada, *Panicum decipiens, P. Bergii, Setaria onurus, Eragrostis Neesii, Rottboellia Selloana, Aristida pallens, A. murina* y *Stipa Neesiana*. Varia especies americanas son abundantes; *Eragrostis lugens, Andropogon saccharoides-laguroides, Setaria geniculata, Paspalum plicatulum* y *Axonopus compressus*. Hay varias cosmopolitas muy abundantes: *Sporobolus Poiretii, Lolium multiflorum, Poa annua*.

Son muy numerosas las hierbas hemicriptófitas leñosas y las de raices engrosadas (xylopodium y tubérculo), de los géneros *Vernonia, Aspilia, Eupatorium, Calea, Verbena, Lippia, Adesmia* y *Galactia, Desmanthus*. Los arbustos son escasos, bajos o semi-enanos por el pastoreo. Extensas colonias de *Eupatorium buniifolium* (1-2 mts. de alto) se hallan en varias localidades del Uruguay. *Baccharis trimera*, de 20 a 50 cms. de alto se halla esparcido, pero con mucha frecuencia, igual que el *Baccharis coridifolia*. En los raros campos no pastoreados, existen relictos de otros *Baccharis, Discaria longispina, Vernonia nudiflora* y otros, que el ganado hace desaparecer.

El pastoreo continuado desde hace siglos, ha aumentado las hierbas arrosetadas: *Hypochoeris, Chaptalia, Eryngium nudicaule;* las enanas *Chevreulia stolonifera, Dichondra repens, Oxalis;* las anuales *Soliva sessilis, Micropsis involucrata* y varias malas hierbas invasoras: *Ambrosia tenuifolia, Baccharis subpingraea. Cynara cardunculus, Sylibum marianum* y otros cardos europeos han llegado a ser dominantes en algunas zonas.

Los bosquecillos cubren una superficie muy reducida, que no alcanza para las necesidades económicas. Las especies industriales cultivadas son exóticas, y toda la madera de mueblería se compra en el extrangero. Se distinguen 4 tipos de bosques: ribereños, sábanas, serranos y marítimos.

Los bosquecillos ribereños marginan todos los ríos y arroyos, extendiéndose de 30 a 100 (-2000) mts. de ancho en cada costado. Los arbolitos llegan a 4 o 6 mts. de alto, 8 o 10 en ríos del Norte, esto es de altura media. No hay familias predominantes, pero las de mayor número de especies son: *Euphorbiaceae, Myrtaceae*, y *Leguminosae* en el Oeste y Norte. Las especies más frecuentes son: *Blepharocalyx Tweediei, Eugenia cisplatensis, E. glaucescens, Sebastiania Klotzschiana, Pouteria neriifolia, Salix Humboldtiana, Erythrina crista-galli, Berberis laurina*. En el Norte se agregan *Eugenia strigosa, Lithraea brasiliensis, L. molleoides, Sapium, Rapanea, Cytharexylon*, etc.

Las sábanas que marginan a los bosques ribereños, se componen de una pradera con árboles-arbustivos esparcidos densa o ralamente. Estos árboles-arbustivos, son semi-xerophíticos, espinosos, de hojas pequeñas y de 2 a 4 mts. de altura. Ellos son: *Acacia farnesiana, Celtis tala, Schinus polygamus* y *Scutia buxifolia*. En la costa del río Uruguay la sábana es más extensa, llegando a 10 kmts. de ancho; se compone principalmente de leguminosas: *Prosopis juliflora, Acacia, Gourliea decorticans*, además *Aspidosperma quebracho-blanco*.

El pastoreo y el hombre han disminuido la sábana principalmente y han facilitado la mezcla de las especies de la sábana en el bosque ribereño, raleado a su vez.

Los escasos bosquecillos de la ribera marítima son muy arbustivos, xerofíticos y de 2 a 3 mts. de altura. Las especies frecuentes son *Schinus polygamus, Celtis tala, Colletia cruciata, Erythrina crista-galli, Dodonaea viscosa, Rapanea, Baccharis*, etc.

Los bosquecillos serranos tienen las mismas especies que las formaciones descriptas, pero dispuestas según la topografía, el ambiente ripario se halla en los valles abrigados y a lo largo de vertientes y manantiales; las especies xerófi-

tas como *Colletia cruciata* y *C. spinosa*, y formas de adaptación xerofítica de *Schinus, Celtis, Eugenia, Blepharocalyx, Sapium, Sebastiana* en los lugares más expuestos a los vientos, y a la sequedad.

Los bañados se extienden a lo largo de ríos y arroyos, o rodeando lagunas o en los valles de las praderas onduladas, abarcando muchos kilómetros de ancho y de largo frecuentemente. En los ambientes paludosos predominan ciperáceas: *Scirpus riparius, S. californicus, Cyperus giganteus, Heleocharis dunensis, H. bonariensis, Rhynchospora corymbosa* y varias gramíneas: *Panicum grumosum, P. prionitis, Leersia hexandra, Luziola leiocarpa* y además *Pontederia cordata, Jussieua montevidensis* y *Echinodorus grandiflorus*. Son pacidos en verano. En las proximidades de la costa marítima es muy frecuente el *Scirpus giganteus*. En los ambientes puramente acuáticos *Eichhornia azurea* suele formar densas y sólidas colonias flotantes. *Lemna, Azolla, Riccia* y otras minúsculas plantas tapizan las superficies de las aguas.

Los palmares de *Butia capitata* del departamento de Rocha, cubren una zona de campos bajos, uliginosos frecuentemente, y con denso tapiz graminoso. El ganado come los frutos y las plantas jóvenes, amenazando con hacer desaparecer esta formación. En zonas adyacentes al río Uruguay existen tambien, relictos de antiguos palmares.

Los cerros y lomas rocosas se hallan por todo el país, pero con más frecuencia en el este. En muchos lugares, la vegetación arborescente y despues la arbustiva han desaparecido, sustituidas por arbustillos enanos, hierbas y gramíneas. Se caracterizan por la abigarrada mezcla de ambientes ecológicos. Existen especies características de esta formación: *Baccharis ochracea, Heterothalamus alienus, Dyckia montevidensis* y *Blepharocalyx angustifolius;* ellas son numerosas, pero ninguna importante o generalizada. Esta formación es muy rica en especies y la más atractiva para herborizar, pero tiene muy bajo valor económico.

Los arenales marítimos marginan la costa del río de la Plata y del océano Atlántico en un ancho hasta de 10 kmts. Se hallan cubiertos de arbustos, hierbas y gramíneas, siendo raros los árboles. Las especies más frecuentes son *Panicum racemosum, Paspalum pumilum, Panicum Gouinii, Baccharis rufescens, Ischaemum Urvilleanum* y *Senecio crassiflorus*. En muchas localidades dominan dunas móviles e invasoras. Se ha establecido en los arenales marítimos, una importante industria turística de balnearios. En los lugares influidos por la salinidad existen especies halófilas: *Juncus acutus, J. maritimus, Polypogon maritimus, Cotula coronopifolia* y *Salicornia fruticosa*, reunidas en densas colonias frecuentemente.

Las plantas vasculares catalogadas hasta 1930 son 2274 indígenas y 519 exóticas (HERTER). Las familias más importantes, sumando las especies nativas y espontáneas naturalizadas, son: *Compositae* 371 (*Baccharis* 52, *Eupatorium* 32, *Senecio* 27), *Gramineae* 327 (*Paspalum* 29, *Panicum* 26, *Stipa* 22, *Eragrostis* 22, *Leguminosae* 169, *Cyperaceae* 101 (*Cyperus* 26), *Euphorbiaceae* 79, *Solanaceae* 67 (*Solanum* 26), *Cactaceae* 67 (*Echinocactus* 40), *Malvaceae* 54, *Oxalidaceae* (*Oxalis* 49), *Umbelliferae* 41, *Rubiaceae* 41, *Labiatae* 40, *Asclepiadaceae* 38, *Verbenaceae* 35, *Scrophulariaceae* 33, *Orchidaceae* 32, *Polygalaceae* 30, *Mirtaceae* 29 (LEGRAND), *Convolvulaceae* 28, *Iridaceae* 27, *Amaranthaceae* 24. Los pocos endemismos existentes son muy raros: *Cocos stolonifera, Tillandsia Arequitae, Oxalis monticola*.

Los botánicos que han herborizado en mayor cantidad han sido: COMMERSON, A. DE SAINT HILAIRE, SELLOW, GIBERT, ARECHAVALETA, BERRO, OSTEN y HERTER, por órden cronológico. Las publicaciones más importantes para el estudio de la flora son: MARTIUS, Flora Brasiliensis; GIBERT, E., 1873, Enum. Plant. Spont. Nasc. Agro Montevid.; ARECHAVALETA, J., Flora Uruguaya, Anal. Mus. Nac. Mont. 1894-1911; GASSNER, G., 1913, Uruguay I-II, Vegetationsbilder, KARSTEN y SCHENCK, 11:1-4; Escritos de D. A. LARRAÑAGA I-III, Atlas I, 1922-1927 (esta obra fué escrita en 1808-1822); HERTER, G., 1930, Florula Uruguayensis.

FALCULTAD DE AGRONOMÍA,
MONTEVIDEO.

A. BOERGER: **Recursos Vegetales del Uruguay:** — Situado sobre 30°05 y 35° de latitud Sur y 26°15′ y 60°45′ longitud occidental de París, el Uruguay ocupa una extensión territorial de 186.926 km². Su posición geográfica determina las características salientes de su vegetación espontánea y su producción agrícola. La casi totalidad de la referida extensión territorial debe considerarse en principio apta para producir especies vegetales de interés económico. Solo terrenos pedregosos en las cuchillas que como elevaciones poco pronunciadas atraviesan el país y las tierras anegadizas sobre la costa del Atlántico y la llanura adyacente a la Laguna Merím, superficies más o menos extensas conocidas como "bañados," requerirán la intervención previa del hombre a fin de llevarlas a un más alto grado de producción. Las aludidas elevaciones desprovistas de tierra vegetal y por ende no aptas para la agricultura y la producción de abundantes pasturas deben considerarse, sin embargo, de interés para plantaciones forestales futuras. Y los terrenos bajos, una vez sometidos al trabajo de canalización etc., representan un factor singularmente valioso del potencial productivo.

Pero considerando las cosas en su estado actual, cabe calificarse al Uruguay como país ganadero por excelencia. Tanto las condiciones climatéricas que permiten el pastoreo permanente sin estabulación como también las características agrológicas y la configuración ligeramente ondulada de la superficie, favorecen la ganadería basada sobre le vegetación espontánea de pasturas naturales. Según el último censo agropecuario de 1937, el stock ganadero asciende a 8.226.890 bovinos, 17.931.327 ovinos y 644.200 equinos, cifras estas que abarcan el grueso de la producción ganadera. Ellas interesan aquí en su relación con la producción vegetal, ya que son el exponente de la posición predominante que en el Uruguay ocupan los herbazales (grasslands) como reglón básico de los recursos vegetales del Uruguay.

Cabe señalar, pués, la superficie global de 14.000.000 hectáreas cubiertas con pasturas naturales como característica predominante de la vegetación uruguaya. Esta posición sobresaliente de los vegetales al servicio de la ganadería se acentúa aún más al tener presente que el renglón más importante de la agricultura consiste en aproximadamente 600.000 hectáreas de avenales de pastoreo. Se trata del cultivo extensivo de distintas variedades de *Avena sativa* y *A. byzantina* para fines de pastoreo durante la estación

fría. Menos importante resulta la previsión forrajera para la estación calurosa, cultivándose principalmente Sudan-grass y en menor escala otros sorgos y maíz forrajero, destinados principalmente para la alimentación del ganado lechero.

Estos recursos vegetales destinados a la explotación ganadera encuentran su complemento en los distintos renglones de la producción agrícola propiamente dicha. La importancia de la agricultura contemporánea se refleja a través de las subsiguientes cifras:

*Superficies cultivadas durante el quinquenio de 1935/36 a 1939/40 según datos promediados de la Estadística Oficial:*

| | | |
|---|---|---|
| Trigo | 489.548 | hectáreas |
| Maíz | 221.719 | hectáreas |
| Lino (oleaginoso) | 164.700 | hectáreas |
| Avena | 86.323 | hectáreas |
| Cebada forrajera | 13.630 | hectáreas |
| Porotos | 9.236 | hectáreas |
| Boniatos | 9.370 | hectáreas |
| Papas | 7.197 | hectáreas |
| Alfalfa | 4.340 | hectáreas |
| Maní | 1.918 | hectáreas |
| Centeno | 144 | hectáreas |

Datos no oficiales que representan cifras de estimación de distinto orígen para uno de los últimos años:

| | | |
|---|---|---|
| Pasturas naturales | 14.000.000 | hectáreas |
| Avena para pastoreo | 600.000 | hectáreas |
| Sudan grass y otros sorghos forrajeros | 10.000 | hectáreas |
| Girasol | 50.000 | hectáreas |
| Cebada cervecera | 7.000 | hectáreas |
| Arroz | 6.000 | hectáreas |
| Remolacha azucarera | 1.500 | hectáreas |
| Hortalizas | 10.000 | hectáreas |
| Fruticultura | 42.000 | hectáreas |
| Viñedos | 16.000 | hectáreas |
| Bosques | 600.000 | hectáreas |

La información numérica ofrece inmediatamente una orientación global sobre la importancia de los distintos grupos o especies vegetales. La preponderancia de las pasturas naturales y de los cultivos forrajeros para fines de pastoreo dió motivo a que la botánica sistemática dedicara preferente atención al estudio de la flora pratense. Entre ella figuran las numerosas especies del género *Paspalum* como pasturas buenas. Las del género *Stipa* en cambio, conocidas vulgarmente bajo la denominación "espartillos" y "flechillas," representan tipos inferiores. La publicación de G. E. SPANGENBERG, citada al final, informa no solo sobre estas y otras especies integrantes de la vegetación espontánea del campo natural, sino también sobre el avance de las especies inferiores y la introducción de un gran número de representantes poco valiosos de la vegetación adventicia.

La agricultura extensiva como también la horti- y fruticultura orientadas preferentemente hacia la finalidad de satisfacer el consumo interno, se vienen extendiendo en forma lenta pero firme. Corresponde señalar expresamente la importancia de la citricultura cuyo centro principal actualmente se encuentra en el Departamento de Salto. La implantación del cultivo arrocero, acontecimiento que pertenece también a los últimos años, merece ser destacado en la misma forma como el incremento extraordinario que viene tomando la siembra del girasol como oleaginosa destinada para la producción de aceites comestibles. En el mismo órden de ideas señalo también el aumento de las plantaciones del olivo a cuyo efecto se dan facilidades especiales a raíz de una ley de fomento de este cultivo. La viticultura satisface el consumo interno. En fruticultura se nota un incremento de las plantaciones de manzanos, aunque el duraznero siempre sigue siendo el árbol frutal más difundido, a pesar de una creciente diseminación de las variedades de madurez mediana a tardía, debido al ataque por la mosca del mediterráneo: *Anastrepha fratercula.*

Careciendo el Uruguay prácticamente en absoluto de reservas forestales, se vienen acentuando las plantaciones artificiales. Se trata preferentemente de distintas especies de eucaliptos y en la región sobre el Atlántico también de pinos.

No se cultivan plantas medicinales. Sin embargo se recogen muchas especies silvestres consideradas de utilidad en la terapeutica naturista figurando al final indicaciones bibliográficas sobre el particular.

El fomento de la producción vegetal incumbe en primer término al Ministerio de Ganadería y Agricultura de Montevideo como rama del Poder Ejecutivo competente en estas cuestiones. A tal efecto dicha Secretaría del Estado cuenta con distintos organismos técnicos.

A la Dirección de Agronomía, organismo más bien técnico-administrativo, le corresponde orientar a los interesados en los distintos aspectos de la práctica productiva. Varias dependencias de consulta y de asesoramiento funcionan como "Divisiones" o "Servicios" técnicos en la misma Capital del país, organismos centrales que encuentran su complemento en las "Oficinas Agronómicas" destacadas en campaña.

Dada la importancia que en cualquier proceso de la producción vegetal le incumbe al elemento reproductivo o sea la simiente en el sentido más amplio de la palabra, se ha venido dedicando preferente atención a la organización de los servicios especializados en esta materia. La mencionada Dirección de Agronomía cuenta con la Sección Forestal en Toledo (Dpto. Canelones). Esta, además de dedicarse a la multiplicación de árboles forestales y frutales, tiene a su cargo también la repoblación forestal de costas é islas. En cuanto a la fruticultura, cabe señalar como complemento de los cometidos de Toledo, la tarea de enseñanza práctica y de orientación comercial etc., a cargo de la División Industria Frutícola con sede en Montevideo.

Todo lo relacionado con la distribución de "buena semilla" de las distintas especies agrícolas como trigo, maíz, lino, avena, cebada y luego también semillas de papas, forrajeras, etc., está a cargo del Servicio Oficial de Distribución de Semillas en Montevideo. A tal efecto esta institución cuenta no solo con las instalaciones y equipos de limpieza y clasificación mecánica de semillas, sino también con "Semilleros de Multiplicación" instalados bajo su control en la propiedad privada. La correspondiente "Sección Técnica" produce así, a través de un servicio de fiscalización oficial, la semilla "certificada." Su importancia en el proceso productivo no requiere comentarios al tener presente que en ninguna parte del mundo la producción agrícola general se basa en la siembra de semilla "original" de pédigree cuya producción suele ser escasa.

Para contemplar este aspecto de la producción, el Ministerio de Ganadería y Agricultura cuenta también con un organismo de genética vegetal aplicada, o sea el Instituto Fitotécnico y Semillero Nacional La Estanzuela (Dpto. Colonia). Esta institución representa a la vez un organismo de alta investigación en problemas afines. La fitotécnica contemplada por la creación de variedades mejoradas de las principales

especies agrícolas encuentra así su complemento en investigaciones agrotécnicas relacionadas con problemas de la labranza, de los fertilizantes, etc. Y cabe destacar expresamente que el Instituto de La Estanzuela, a través de las actividades de su "Sección Plantas Industriales y Forrajeras," colabora también con la Comisión Nacional de Estudio del Problema Forrajero adscripta directamente como organismo técnico al Ministerio de Ganadería y Agricultura.

Teniendo presente la preponderancia de las pasturas naturales en todo lo relacionado con la producción vegetal del Uruguay, las actividades de dicha Comisión son singularmente importantes. No solo para confeccionar el "inventario" de las especies vegetales más interesantes de este renglón de la producción vegetal, sino también para la conservación y aún el mejoramiento de los grass-lands, la labor realizada es de mucha utilidad. En el mismo órden de ideas cabe señalar las actividades desplegadas por iniciativa privada en varios grandes establecimientos ganaderos por el Ing. Agr. JUAN P. GALLINAL y otros.

Las realizaciones oficiales sostenidas y orientadas por el Ministerio de Ganadería y Agricultura encuentran su complemento en la labor de investigación desplegada en la Facultad de Agronomía de Montevideo. Institución Universitaria destinada en primer término a la función docente, la referida Facultad, a través de las Cátedras dedicadas a las respectivas materias de Botánica, Agricultura, Horticultura, Fruticultura, Silvicultura, etc., no descuida tampoco las tareas de investigación propiamente dichas. Estas, en su faz práctica de orientación de la campaña quedan complementadas con la colaboración de las Escuelas de Práctica y Campos Experimentales de Agronomía que funcionan en Salto, Paysandú y Cerro Largo como organismos de experimentación dependientes de la precitada Facultad. Cuenta ella también con una Cátedra de Genética General y una Estación de Genética dependiente de la Cátedra de Agricultura. Quedan contempladas así, dentro de lo posible, también las exigencias contemporáneas respecto a la necesidad de profundizar en conocimientos teóricos relacionados con la producción vegetal, por instituciones universitárias.

La Sección Botánica del Museo de Historia Natural en Montevideo y el Jardín Botánico dependiente del Municipio de la misma ciudad, se dedican preferentemente a cuestiones de la Botánica Sistemática.

Dada la importancia que dentro del renglón fruticultura le corresponde a la citricultura, no dejo de mencionar expresamente la creación, por parte de la Dirección General de Enseñanza Industrial, de la Escuela Industrial de Citricultura en Salto, actualmente el centro más importante de la citricultura uruguaya, organismo que se dedica a investigaciones de toda índole inclusive la de carácter fitopatológico.

Entre los problemas fitopatológicos contemporáneos que afectan a la producción uruguaya corresponde señalar la langosta *Schistocerca paranensis* Burm., el Pulgón verde (*Toxoptera graminum* Rond.), la vaquilla (*Epicauta adspersa*), que ataca las papas y *Quenopodiáceas*, las hormigas (*Atta* sp.) y desde luego también los distintos pulgones y las cochinillas que atacan los árboles frutales. En la agricultura propiamente dicha figuran los carbones (*Tilletia tritici* y *Ustilago* sp.), las royas (*Puccinia* sp.), el pietin (*Ophiobolus graminis*), *Septoria tritici* y *S. nodorum*, como afecciones parasitárias del trigo. *Septoria linicola* como también *Fusarium lini* se registran como enfermedades talvez más importantes del lino. El género *Fusarium* está representado por muchas otras especies que atacan un buen número de plantas cultivadas y especialmente leguminosas. En fruticultura y viticultura se registran las plagas corrientes también en otros ambientes, en virtud de lo cual no hay que nisistir sobre detalles. Cabe señalar sin embargo, expresamente que la mosca de la fruta tan temible *Anastrepha fraterculа* hizo su aparición recién en los últimos años.

La lucha práctica contra las afecciones parasitárias está concentrada en la Dirección de Agronomía que a tal efecto cuenta con la Sección Defensa Agrícola. Pero en el mismo organismo se realizan a la vez investigaciones fitopatológicas a cargo de la División de Patología Vegetal y Entomología. La Facultad de Agronomía cuenta en este terreno de especialización con la Cátedra de Fitopatología. El Instituto Fitotécnico y Semillero Nacional La Estanzuela dedica atención especial a las afecciones parasitárias de las plantas agrícolas, investigaciones a cargo de la Sección Fitopatología.

INSTITUTO FITOTÉCNICO Y SEMILLERO NACIONAL
"LA ESTANZUELA",
DEPTO. COLONIA, R. O. DEL URUGUAY.

La subsiguiente lista indica algunas de las fuentes bibliográficas que a los interesados les permitirá ampliar esta información sintética.

*Pasturas naturales:* —
ARECHAVALETA, J., Las gramíneas uruguayas. Montevideo, 550 pp., 71 lám., 15 fig., 1894.
SPANGENBERG, G. E., Normas a observar en el mejoramiento de nuestras praderas naturales. Montevideo, Rev. Fac. Agron. 3:311/402, 1930.
GALLINAL HEBER, J. P., BERGALLI SOÑORA, L. U., CAMPAL GOMEZ, E. F., ARAGONE LEONARDI, L. y ROSENGURTT GURVICH, B., Estudios sobre praderas naturales del Uruguay. Primera contribución. Montevideo, 208 pp., 1938.
*Agricultura y genética vegetal aplicada:* —
BOERGER, A., Observaciones sobre agricultura. Quince años de trabajos fitotécnicos en el Uruguay. Montevideo, 580 pp. con muchas figuras y gráficos, 1928.
*Fruticultura, Horticultura, Silvicultura:* — Hasta el presente no existe una obra completa de carácter nacional, sino solamente publicaciones monográficas de detalle.
*Plantas medicinales:* —
GONZALEZ, M., COPPETTI V. y LOMBARDO, A., Plantae diaphoricae Florae uruguayensis, Tomo I. Montevideo, 154 pp., 1928.
GONZALEZ, M., LOMBARDO, A. y VALLARINO, A. J., Plantas de la medicina vulgar del Uruguay. Montevideo, 150 pp., 167 fig., 1939.

T. H. GOODSPEED: **Notes on the Vegetation and Plant Resources of Chile:** — The republic of Chile comprises a narrow band of territory on the west coast of South America almost 40° (17°57'S-55°59'S) in extent and lying between the Andes and the Pacific. Its coast line is between 2800 and 2900 miles, from the tropics to the subantarctic, and its average breadth is somewhat less than 100 miles. From the Peruvian border to approximately 41°S it is essentially a longitudinal valley between a lower coast range on the west and the higher Andes on the east. The latter diminish in height southward while below 42° the coast range is broken by intruding arms of the sea with the formation of archipelagos. Over 70% of the republic is mountainous. There are three geobotanical zones: I, an essentially rainless area between 19° and 30°50', the northern portion of which approaches the absolute desert more closely than any other part of the world and is largely destitute of vegetation, II, a Mediter-

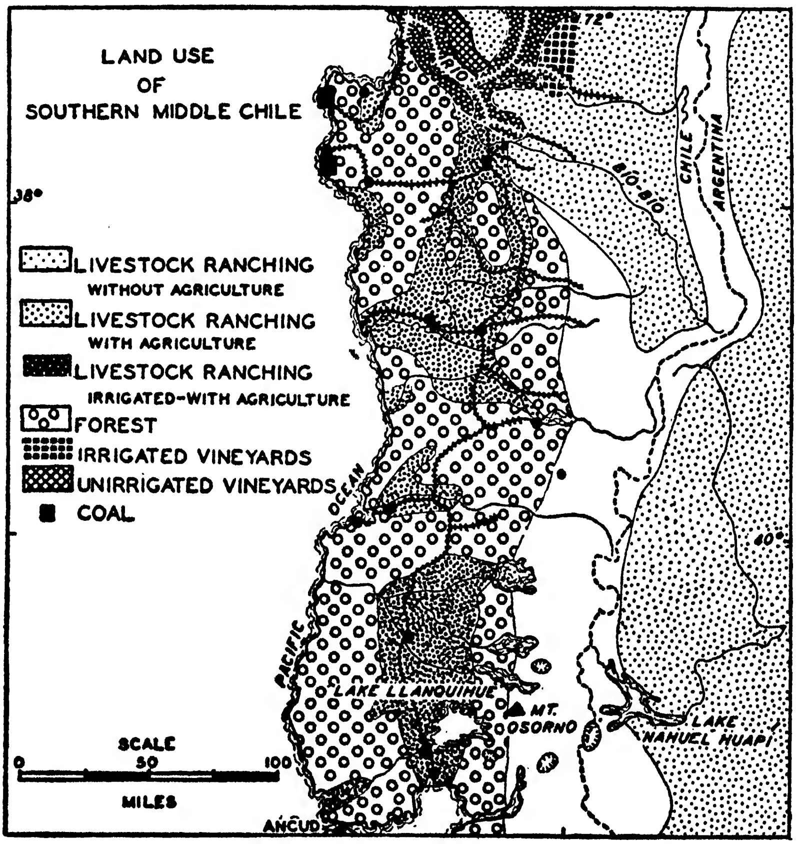
ranean area between 30°50′ and 37° with a dry summer and some to considerable rain in the winter and, III, a humid area between Concepción and Tierra del Fuego (37°-56°) with year round precipitation which may locally exceed 200 inches and is reflected in the presence of heavy forests and dense undergrowth. There is, in addition, the alpine vegetation of the Andean highlands, primarily in zones I and II. The vegetation is, therefore, most abundant in the north and diminishes as the tropics are entered and this is to be explained by the nature of prevailing winds and ocean currents. Thus, northern Chile is arid because the winds are from the south and such moisture as they carry is condensed by the cold, shorewise Humboldt current more effectively than by the rising land surface. From approximately 27° southward the ocean and land temperatues begin to approach that of the Humboldt current so that some rain falls on the coast and more in the Andes, especially in the winter when the land surface is coldest. South of 33° westerly winds prevail and decreasing ocean and land temperatures eliminate the cold coastal current as an intercepting agent. In the northern arid to semi-arid half of the republic the longitudinal valley is interrupted by spurs of the Andean range and by isolated peaks. East of the coastal range, which reaches altitudes of 4000 to 6000 feet, a rolling plateau composed of sands, gravels, rocky outcroppings, and salt basins extends to the nitrate deposits in the foothills of the Andes. These foothills rise rapidly and with regular slope to the Andean crest which averages over 12,000 feet in altitude and culminates somewhat to the south in the Mercedario and Aconcagua massifs with peaks above 20,000 feet.

The coastal strip in zone I from the Peruvian border to 20°S is almost completely barren. South of this point heavy sea fogs lying on the coastal hills during the winter provide sufficient moisture for the development of a seasonal flora. Similar atmospheric conditions along the Peruvian coast produce the so-called "flora of the lomas" or "*loma* formation." On the Chilean coast this *loma* vegetation is best developed on the coast range in Depts. Chañaral and Taltal of Provs. Antofagasta and Atacama. JOHNSTON has studied the coastal vegetation of northern Chile between 20° and 24° and lists 117 species of which 23 are endemic and 5 are Peruvian species. Between 24° and 26°50′ the coast range shows four vegetational zones: (1) below the lateral belt of fog (2) within the fog belt (3) above it and (4) behind it. In (1) desert conditions obtain and such xerophytic shrubs as *Heliotropium pycnophyllum, Ophryosporus triangularis, Chuquiraga ulicinia* occur along with *Echinocactus cinereus,* species of *Calandrinia, Adesmia, Oxalis, Cristaria.* On the sandy ocean beach immediately below are species of *Dioscorea, Microphyes, Skytanthus* and *Coldenia. Cereus coquimbanus, C. spinibarbis* and *Euphorbia lactiflua* are characteristic plants of (2) which JOHNSTON refers to as the "fertile belt." With them grow *Oxalis gigantea, Heliotropium philippianum, Salvia gilliesii* and *Proustia tipia,* sometimes forming small thickets. *Puya copiapina, Nicotiana solanifolia, Peperomia doelli* and *Alstroemeria violacea* are conspicuous. *Erodium cicutarium* often forms a ground cover. Also listed are 7 genera of grasses, 10 of higher monocotyledons, and 12 of perennial dicotyledons. By contrast (3) contains an arid scrub of *Echinocactus* and low bushes, a series of deep-rooted xerophytes and, above 3000 feet, completely barren slopes. Among the species at the upper limit of vegetation are *Calandrinia sitiens, Oxalis ericoides, Adesmia viscidissima* and *Argylia sitiens.* The most characteristic shrubs of (4) are species of *Gypothamnium, Oxyphyllum* and *Chuquiraga* while the herbaceous flora is similar to that of (1) but poorer.

The vegetation of the northern portion of zone II, a "Mediterranean" zone, is seen in Prov. Aconcagua and adjacent areas (*cf.* GARAVENTA). On or near the sea occur *Solanum maritimum, Carpobrotus chilensis,* species of *Puya,* and *Neoporteria subgibbosa,* with *Baccharis concava, Fuchsia rosea* and *Trichocereus litoralis,* somewhat more inland. In small coastal valleys, *Myrceugenia stenophylla* and *apiculata, Proustia pyrifolia, Cissus striata, Passiflora pinnatistipula,* and scattered trees of *M. thalassica* are characteristic, with thickets of *M. exsucca* in the numerous small marshes. The coastal range becomes dissected in the northern portion of zone II and on the lowlands, higher plateaus, and mountainsides up to 2500 feet typical species include (1) *Crinodendron patagua, Bellota miersii,* and *Aristotelia maqui* near running water, (2) *Typha angustifolia* and *Scirpus riparia* in seasonally inundated portions, (3) *Baccharis marginalis, Tessaria absinthioides, Psoralea glandulosa, Salix humboldtiana* and *babylonica, Rubus ulmifolius* and *Acacia dealbata* in and near the beds of seasonally dry streams, (4) *Boldea boldus* (*Peumus boldus*), *Cryptocarya rubra, Schinus latifolius, Maytenus boaria, Cestrum parqui,* and *Quillaja saponaria, Lithraea caustica, Escallonia rubra* and a number of species of *Mutisia* in favored locations on slopes while (5) *Acacia cavenia, Trevoa trinervis* and *Porliera chilensis* and species of *Adesmia* and *Acacia* represent the characteristic associations of drier regions and thus of large portions of lower altitudes in northern zone II during two-thirds of the year. At higher altitudes (to 4500 feet) on isolated mountains or short ranges, the northern limit of *Nothofagus obliqua* var. *macrocarpa* is found along with such species of the precordillera as *Chuquiraga oppositifolia, Valenzuelia trinervis* and *Berberis chilensis.* In addition to the latter, the vegetation of the precordilleran region includes *Kageneckia angustifolia, Eccremocarpus scaber* and *Gymnophyton polycephalum.* The high Andean vegetation below the snow line (approximately 14,000 feet in central Chile) is characterized by the remarkable mound or cushion forming *Umbelliferae* of the genera *Laretia* and *Azorella,* and principally *Laretia acaulis.* Other species of similar growth type are *Mulinum spinosum* and *Berberis empetrifolia* while *Nassauvia macracantha, Cajophora coronata, Tropaeolum polyphyllum* and *Nicotiana corymbosa* are among the species characteristic of somewhat lower altitudes. The herbaceous spring (October and November) flora of zone II below and into the precordilleran region is exceedingly rich, including such genera as *Scilla, Valeriana, Stellaria, Oxalis, Lathyrus, Trifolium, Alonsoa, Anemone, Sisyrinchium, Dichondra, Loxodon, Cardamine, Libertia, Francoa, Hippeastrum, Conanthera, Godetia,* and *Leucocoryne.* Originally found in large numbers from Río Limarí to Río Maule,

the Chilean palm, *Jubaea spectabilis,* is today much reduced in distribution and will soon be in danger of extinction.

Southward, in zone III, precipitation increases rapidly to produce a sometimes almost impenetrable temperate rain forest over large areas from somewhat south of Valdivia to Magellan Strait. The principal component of the south Chilean forests is the false beech, *Nothofagus,* of which a series of species is recognized. According to URBAN, *N. obliqua* (with its northern limit in Prov. Aconcagua) is abundant below Prov. Santiago on slopes of the Andes and the coastal range to Prov. Chiloé, usually forming mixed stands with *N. dombeyi.* The latter ranges from 35°50′ to Prov. Aysen (45°) and up to considerable altitudes where it is replaced by *N. pumilio* and *N. antarctica.* Heavy stands of *N. pumilio* occur at moderate altitudes in Provs. Valdivia and Chiloé and at sea level in Prov. Magallanes. Like *N. pumilio, N. antarctica* has its northern limit at approximately 37° in Cords. Chillán and Nahuelbuta and is replaced below Prov. Chiloé by the closely related species *N. montagnei* which is abundant in the Magellanic archipelago and the zone of the Strait. Of more limited distribution (Linares to Valdivia) is *N. procera* characteristic of lower Andean slopes and abundant in the coastal range from Cord. Nahuelbuta southward. *N. betuloides* and *N. nitida* have the most southerly distribution—from the coastal range in Prov. Valdivia to Tierra del Fuego—and are everywhere abundant therein. Together with *Nothofagus* the Chilean forests contain nine coniferous species of seven genera, one (*Saxegothea*) endemic and monotypic. Some are limited in distribution, others approximate species of *Nothofagus* in their northward extension, while others are peculiar to the far south. Thus, like *N. betuloides* and *N. nitida, Pilgerodendron uviferum* is found from Valdivia (40°) to Tierra del Fuego and *Dacrydium fonckii* (40°-50°), a rare species, and *Podocarpus nubigenus* (39°-48°), scattered in occurrence, approximate the distribution of *N. montagnei* but do not occur as far south. The range of *N. dombeyi* and that of *Fitzroya cupressoides* (39°45′-43°29′), *Saxegothea conspicua* (35°20′-45°) and *Libocedrus chilensis* (24°25′-44°) in general correspond. With *N. obliqua, N. procera* and *N. pumilio* may be found *Podocarpus salignus* (35°-41°) and *P. andinus* (37°30′-41°), a scarce species of limited distribution. Of most restricted range is *Araucaria araucana* with two centers of occurrence. In the coastal range, and especially in Cord. Nahuelbuta, it extends from 37°20′ to 38°40′ while its Andean distribution in Chile is from 37°50′ to 39°40′ (but to Lago Nahuelhaupi in Argentina). Particularly in the Cord. Nahuelbuta it forms rather pure stands and its general altitudinal range is between 2500 and 6000 feet. The *Myrtaceae* (7 genera and some 50 species in Chile) are often conspicuous elements of the




(*From* JAMES's Latin America, New York, 1942)

humid southern forests. Dense and extensive thickets of *Tepualia stipularis* occur in Provs. Valdivia and Chiloé and particularly in Prov. Aysen. *Myrceugenia luma* is abundant in the same area and of more restricted range is *Ugni molinae*. Certain proteaceous genera are typical of zone III—*Lomatia ferruginea* and *L. dentata* (from 35° southward, common in Provs. Valdivia and Chiloé), *Guevina avellana* and *Embothrium coccineum*. From 34° to Puerto Montt *Laurelia aromatica* is present while farther south and at higher altitudes it is said to be replaced by *L. serrata*. In mixed stands with the former species are *Persea lingue, Pseudopanax laetervirens, Crinodendron hookerianum, Aextoxicum punctatum, Flotowia diacanthoides, Weinmannia trichosperma,* and *Eucryphia cordifolia*. The northern limit of occurrence of *Sophora tetraptera* is the Río Maule, and northward occurs *S. macrocarpa*. *Drimys winteri* has an extended distribution from 31° to Cape Horn but as a forest tree is restricted to the humid zone. In more open areas in the rain forest solid thickets composed of species of *Chusquea* are characteristic. A dense understory and ground cover of shrubs, lianas, ferns, mosses, etc., include such genera as *Ovidia, Eugenia, Azara, Aristotelia, Desfontainea, Baccharis, Fuchsia, Berberis, Gunnera, Lapageria, Lardizabala, Pernettya, Nertera, Mitraria, Sarmienta, Blechnum, Hymenophyllum, Dryopteris, Adiantum, Polypodium,* and *Asplenium*. In Prov. Chiloé occur a number of species of *Solanum* of the *Tuberarium* group and this fact bears upon the origin of the potato which has often been assigned to the highlands of Bolivia and Peru.

The marked distinctions between the vegetation of Chile and Argentina, suggesting that the Andean barrier existed or was in formation when the floras of temperate South America were being evolved, may be illustrated by the *Cactaceae* of the two republics. LOOSER has pointed out that there are 13 genera in Chile with some 50 species (30 endemic) and in Argentina approximately 150 species only 3% of which are found in Chile. Of endemic genera, 4 occur in Chile (*Neoporteria, Copiapoa, Eulychnia,* and *Eriosyce*) and 7 in Argentina and only one (*Maihuenia*) in both republics. Of these endemic genera, only one of the Argentine contains more than one species (*Pterocactus* with 4) while three of the four Chilean genera have a total of 17 species. Both endemic and non-endemic Chilean genera have almost exclusively Andean (Peru, Bolivia) affinities while the relationships of the Argentina genera are somewhat more largely northeastern (Brazil) but also Andean.

The great diversity existing in the Chilean vegetation, accompanied by a high degree of endemism, is largely a product of extreme climatic zonation in a coastal strip extending from the tropics to the subantarctic and from sea level to over 20,000 feet. In such case interzonal diversity is to be expected but, in addition, intrazonal diversity is, in some instances, unusual due to the presence of isolated northern areas in which are found species peculiar to the south. Thus, in Prov. Coquimbo at the mouth of the Río Limarí, (30° 70′) occurs the remarkable "forest of Fray Jorge." Surrounded by the arid to semiarid vegetation of the southern portion of zone I it contains such species as *Aextoxicum punctatum, Griselinia scandens, Peperomia nummularioides, Sarmienta repens, Mitraria coccinea, Nertera depressa, Dysopsis glechomoides, Peperomia fernandeziana, Uncinia trichocarpa, Polystichum adiantiforme, Blechnum auriculatum, Polypodium feuillei, Dryopteris spectabilis, Adiantum chilense, Asplenium magellanicum, Hypolepis rugosula,* and *Hymenophyllum unilaterale*, almost all of which are not found elsewhere in central Chile and are typical and abundant only at and below the Río Maule (35° 30′). According to LOOSER, a few characteristically southern species (*Nothofagus obliqua, Lomatia obliqua* and *dentata, Bomarea salsilla, Lapageria rosea*, the *Aextoxicum* and some of the ferns of "Fray Jorge") occur sporadically in zone II so that the gap between "Fray Jorge" and the southern vegetation it contains is not complete. The presence of "relic" islands of present day southern species in the north suggests that during a relatively recent geologic period the climate of the latter region, at least to Prov. Coquimbo, was more wet and cold than at present in order to permit a northward current of southern species. In addition, elements of the subantarctic flora have persisted farther north as in the Cord. Pelada (40°50′) where such typically Magellanic species as *Donatia fascicularis, Astelia pumila, Tribeles australis, Dacrydium fonckii, Nothofagus betuloides* and *Spagnum acutifolium* form small colonies surrounded by a distinctly different vegetation. Some of these subantarctic species also occur at higher altitudes on the island of Chiloé and SKOTTSBERG found Magellanic elements in the vegetation of the highlands of Mas Afuera of the Juan Fernandez group.

Beginning in 1778 RUÍZ and PAVÓN spent 11 years on the west coast of South America principally in Peru but also in Chile. Landing in Talcahuano they collected from Concepción to Santiago and at various points in the adjacent Andes. First published in 1776 and 1782 respectively, the *Compendio* and *Saggio* of MOLINA (b. Chile, ca. 1738) represented the only organized body of information on the natural history of Chile available during the early decades of the 19th century. Among others the collections made by LAY and COLLIE of the Beechey expedition (1825-1828) were described by HOOKER and ARNOTT. Between 1827 and 1829, POEPPIG collected in the Valparaiso area, a portion of the central Chilean Andes, and in Prov. Bío-Bío. BERTERO explored the central provinces and Mas a Tierra of the Juan Fernandez group between 1829 and 1830. In 1828 GAY arrived in Chile and during the next ten years collected from Copiapó to Chiloé. Eight of the 28 volumes of his *Historia física y política de Chile* (1845-54, Paris, Santiago) deal with botany and over 3500 species are described. Modern Chilean botany begins with the work of R. A. PHILIPPI (b. Berlin, 1808, d. Santiago, 1904) who came to Chile in 1851 and for almost 50 years was actively concerned with collecting and studying its vegetation. He described over 3000 species, some of them collected by his son FREDERICO. JOHOW's *Estudios sobre la Flora de las islas de Juan Fernandez* (Santiago, 1896) constituted the basis of knowledge of the remarkable vegetation of Chile's insular possessions until the publication of SKOTTSBERG's "The Natural History of Juan Fernandez and Easter Island" (Uppsala, 1920 *et seq.*). The most important contributions to the botany of Chile are REICHE's *Flora de Chile* (Santiago, 1896-1911)

and his *Grundzüge der Pflanzenverbreitung in Chile* (Leipzig, 1907). Over a period of many years, REICHE acquainted himself fully with the Chilean vegetation, as did FUENTES (1876-1934) somewhat later. Among foreign botanists who more or less recently have made collections in Chile are SKOTTSBERG, JOHNSTON, PARODI, BURKART, PERÉZ MOREAU, and MUNZ. Three expeditions (1935-43) from the University of California Botanical Garden, directed by GOODSPEED, collected extensively from Antofagasta to Puerto Montt and on Mas a Tierra and Mas Afuera. Currently, collecting and study of the Chilean floras are being carried on by MUÑOZ, ESPINOSA, GARAVENTA, LOOSER, GRANDJOT, HOLLERMAYER, BAEZA, IBANEZ, and other local botanists.

Of Chile's total land surface of 290,000 square miles, approximately 14,000,000 acres are under plow and of these somewhat over 2,500,000 acres are irrigated. In addition, there are some 500,000 acres of vineyards and orchards and over 50,000,000 acres of open woodland, brushland and natural meadowland suitable for grazing, of which approximately 20,000,000 acres are in Chile's Magellanic provinces and support sheep ranching of increasing importance. Apart from some production of cotton east of Arica, Chilean agriculture begins in the essentially arid provinces of Atacama and Coquimbo but is restricted to the narrow bottoms of the few rivers which reach the sea. Alfalfa is the principal crop (yielding up to 7 cuttings in a year) but some wheat is grown and there are numerous small orchards. Farther to the south in the rich soil of the Aconcagua river valley wheat, alfalfa and some tobacco and hemp are produced. There are many vineyards, orchards and truck gardens; in favored localities grow citrus and such tropical fruits as the chirimoya. In the fertile valley between Santiago and the Río Maule, the grape, wheat, barley, beans, alfalfa and, more recently, rice are produced under irrigation. To this point, from north to south, the agricultural area is called "the arid or semiarid zone" (annual precipitation increasing from 0 to 32 inches). The Provs. Ñuble and Bío-Bío contain unirrigated vineyards and grow lentils, wheat, corn, oats, and clover (replacing alfalfa). In the Provs. Malleco and Cautín, cereals are almost exclusively grown and principally wheat. In this area, erosion is a particularly serious problem. The most southerly region in which field crops are produced includes the Provs. Valdivia, Osorno, and Llanquihue and the island of Chiloé. In this area certain soils are remarkably rich and give high yields of wheat, oats, and potatoes although the fertility of the Chiloé soils has suffered severely from prolonged potato cultivation. Relatively small quantities of potatoes, oats, barley, beans, lentils, onions, apples, walnuts, melons, and dried and canned fruits are exported from Chile. There are large exports of mutton, wool, and sheepskins from the Magellanic provinces. Recognition of the necessity for proper farm mechanization, local production or importation of improved crop varieties, control of soil erosion, standardization of the product and its proper grading and packing for export, improvement in the economic condition of farm labor, and rural education is increasing.

Although native timber of marketable value is found from about 33° to the southern extremity of Chile, its exploitation is largely confined within an area between 37° and 44°. Current lumber production is somewhat above 250,000 board feet annually. Among the species cut, in the order of their commercial importance, are *Nothofagus procera, obliqua* and *betuloides, Laurelia aromatica, Araucaria araucana, Podocarpus nubigenus* and *salignus, Pilgerodendron uviferum, Libocedrus chilensis, Persea lingue* and *Fitzroya cupressoides*. Of these the last is renowned both for the quality of its timber and for its size (up to 200 feet in height and 15 feet in diameter). The *quillai* (*Quillaja saponaria*), once abundant between 30° 30′ and 38°, has been heavily cut for its saponin content. *Eucalyptus* and poplar have long been grown to a limited extent and cultivation of the former is increasing in appropriate climates. Defective lumbering methods and fire are seriously depleting the more available supplies of some of the species most valuable industrially and especially *Araucaria* and *Fitzroya*. Sawmills in the southern provinces are numerous but of limited capacity and poorly equipped. There are a number of paper and plywood mills. Chile's forest resources can become of large importance in her internal economy if correctly exploited. Under an agreement between the United States Department of Agriculture and the *Corporación de Fomento de la Producción* of the Chilean government, members of the United States Forest Service are making a survey of the nature and extent of Chilean forests, studies of logging methods and costs, and of timber species of potential commercial importance. Local reforestation programs are beginning to function and private interest and investment in conservation and tree growing are appearing.

BOTANICAL GARDEN,
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H. K. SVENSON: **A Brief Review of the Galapagos Flora:** — The Galapagos or Tortoise Islands lie directly on the equator 500 miles west of Ecuador. They are of volcanic origin with volcanoes occasionally breaking forth, and the largest of them (Albemarle) is 72 miles long. Outside of the polar regions they are the largest islands without aboriginal inhabitants, and consequently the animal, bird, and plant life was free, until discovery of the islands by the Spaniards, to develop without restrictions. At the time of DARWIN's visit (1835), convicts from Ecuador had been established on Charles Island, and had introduced a number of cultivated plants, and along with them, cattle, goats and burros which now run wild on some of the islands, but which probably have not affected the vegetation greatly. Due to the scarcity of water nearly all attempts at colonization have ended in tragedy. Thousands of gigantic tortoises were seen by DARWIN, but they are now nearly extinct. Climatically the islands are a part of the desert coast of Ecuador and Peru, and any water which they receive is due to sporadic rains which fall from February to April and from condensation of cloud moisture by the southerly winds upon the sides of the mountains, which rise to heights of 5,000 feet on Albemarle and Narborough. Northern slopes are drier, and run down at sea level to dry desert conditions.

A marked altitudinal zonation therefore exists, and the islands show within themselves strong ecological differentiation, with opportunity for pioneering species to extend themselves without great competition into various types of habitat. In general the islands are composed of a porous and fissured lava which does not allow the accumulation of water; soils, such as they are, are relatively homogeneous, or mere accumulation of leaf mold, but scarcity of water is such an outstanding factor that diverse soil-compositions probably would be relatively unimportant.

With present uncertainty as to species limits — groups such as *Scalesia, Acalypha,* and *Peperomia* are separated mainly on leaf characters — the actual number of species is problematic, but the vegetation is meagre for such an extended territory in the tropics. There are about 70 species of Pteridophytes, including a half-dozen endemics; 463 flowering species, excluding cultivated plants, are listed by STEWART, of which 204 (42%) are endemic. Of these endemics 19 are *Scalesia,* 15 *Euphorbia* (out of 17), 13 *Alternanthera* (out of 15), 11 *Acalypha,* and 14 *Borreria,* and these five genera account for 35% of the endemics. A considerable number of supposed endemics have been found on the mainland, and STEWART's enumeration is perhaps too high. However, the rocky shores and treacherous surf and difficulties of progress on foot still leave large unexplored pockets on these islands, which are continually contributing new species. In addition to the marked relationship to the flora of the mainland of South America, there are some striking resemblances to plants of the West Indies. The endemic *Lantana pedunculata* is scarcely, if at all, distinguishable from *L. odorata* of the West Indies, and the same is true of the endemic *Euphorbia viminea,* as compared with *E. vaginulata* of the Bahamas. The largest families are *Compositae* 60 sp., *Gramineae* 47, *Leguminosae* 45, *Euphorbiaceae* 38, *Amaranthaceae* 28, *Cyperaceae* 24, *Rubiaceae* 21, *Solanaceae* 20, *Malvaceae* 18, *Convolvulaceae* 15, and *Boraginaceae* 14.

It is not easy to differentiate floristic groups, since conditions vary so much from island to island and the gradations are often imperceptible. The flowering season is incredibly short, most of the shrubs and herbaceous plants flowering and setting fruit within three weeks' time during the period of rains. Except for the yellow flowers of *Cordia lutea* and *Gossypium* the flowers are inconspicuous, often indistinguishable from the grayish-green foliage of the branches. The landscape of the low regions presents a dreary gray aspect, accentuated by the whitened trunks of *Bursera* trees and *Croton* bushes, which are frequently covered by livid or reddish lichens.

In places along the coast grow halophytic shrubs and trees: *Rhizophora mangle, Conocarpus erectus, Avicennia nitida, Laguncularia racemosa* and *Cryptocarpus pyriformis* — the last-named species, known also from the coast of Peru and Ecuador, forming impenetrable tangles. In sandy open places or on disintegrated lava near the shore grow *Coldenia, Cyperus rubiginosus* and *C. anderssonii,* endemic species of *Mollugo, Alternanthera, Amaranthus, Acalypha,* and numerous little *Compositae,* such as *Chrysanthellum, Pectis* and *Acanthospermum.* Towering over these are the arboreal cacti (*Opuntia myriacanthus* and *Cereus galapagensis*) which occupy the headlands and low areas, and which often reach a height of 40 ft. On the broken lava slopes are dense thickets of *Lantana peduncularis, Cordia galapagensis, Tournefortia pubescens, Solanum verbascifolium, Euphorbia viminea, Scalesia* species, and other shrubs. Bushes with strong spines are in abundance; such as *Scutia spicata* (*Rhamnaceae*), *Lycium minimum, Acacia tortuosa* and *A. macracantha.*

The coastal thickets give way on the lower slopes to a xerophytic forest composed of large trees of *Pisonia floribunda, Psidium galapageium, Xanthoxylum fagara* and *Piscidia erythrina* and the tree-composite *Scalesia pedunculata.* On these trees are species of ferns, *Peperomias,* a single epiphytic orchid (*Ionopsis utricularioides*), and a single bromeliad (*Tillandsia insularis*); the underbush is dense with species of *Tournefortia, Psychotria, Acacia,* and *Cordia,* and further tangled with climbing *Convolvulaceae* and *Cucurbitaceae.* On the steep slopes of the mountains the trees become greatly dwarfed and there are almost impenetrable thickets of *Miconia Robinsoniana,* covered with an orchid, *Epidendrum spicatum,* and festooned with bryophytes, ferns and *Lycopodiums* in a region almost constantly moistened by clouds. On some of the islands grass occupies the highest elevations and allows grazing, as on Chatham Island. On Indefatigable Island plantations have been cut out at the upper edge of the forest zone. On the small low islands, which are hopelessly sterile, there is only naked lava with stunted shrubs. STEWART (Trans. Wisc. Acad. 18: 272-340. 1915) has described the vegetation of the individual islands in detail.

BROOKLYN BOTANIC GARDEN,
BROOKLYN, N. Y.

CARL SKOTTSBERG: **The Juan Fernandez and Desventuradas Islands:** — These two small groups rise precipitously from the Juan Fernandez ridge, which runs NW-SE off Central Chile; on either side the sea is between 3,000 and 4,000 m. deep. All are built of basaltic lavas and tuffs presumably of late Tertiary age.

*JUAN FERNANDEZ:* — The archipelago includes 3 islands, Masatierra, 88 sq. km., distant 670 km. from the coast, Santa Clara, a small islet close to Masatierra, and Masafuera, 53.5 sq. km., 100 km. farther west.

*Masatierra* consists of a high, deeply eroded ridge running approximately E-W; in the eastern section it falls almost perpendicularly to the south coast, the numerous parallel gorges running north; in the wider central section it crosses to the north side of the island, forming a perpendicular wall and ending in the western promontory and Santa Clara; the valleys trend south. The altitude of the crest is about 500 m. at the east end, rises in the central section to about 800 m., culminating in Mt. Yunque (ca. 930 m.), and falls as we go west to less than 100 m. The tilt of the innumerable basalt beds, north in the eastern half, south in the western, explains the topography; in the central section the beds are horizontal, and the two central valleys meet in the Villagra pass, a narrow gate in the crest offering the only passage from one side of the island to the other.

Meteorological observations have been made in the colony at Cumberland Bay near sea-level. The average monthly temperature varies between 18 and 20 centigr. in summer (Dec.-Feb.) and between 12 and 14 in winter (June-Aug.),

the annual rainfall is 1,080 mm. (a 7-year period), of which 80% falls from April to September. The climate is subtropical oceanic with winter rains, differing from that of the opposite coast in being less extreme, both as to temperature and distribution of rainfall, and much more humid. There is no dry season, and frost is unknown. Climatic conditions are, however, very different in different parts of the island, due to the different elevation and topography, and to the wind direction. During Oct.-March 87%, during Apr.-Sept. 66% of the winds are from SW to SE, the prevailing direction being SSE. The result is that much rain falls over the east and central high land, where fogs frequently envelop the ridges; the valleys are deeply eroded and well watered; the forests are confined to this section. The lower, western section is very dry and treeless and erosion is slow, as the stream beds are dry most of the time. The islet *Santa Clara* is waterless and has a desert-like appearance.

*Masafuera* is a solid block everywhere bordered by high cliffs which rise 1,000-1,400 m. along the west side, which is very much higher than the east. The highest summit is Mt. Inocentes, about 1,500 m. The stratification of the lava beds is just as distinct as in Masatierra. Along the west edge of the table-land the longitudinal ridge runs approximately S-N, forming the divide between the spectacular hanging gorges with their waterfalls, and the system of deep valleys running east, those draining the higher south half of the island cut down and back in the shape of magnificent canyons, so narrow at the bottom that after every downpour the stream occupies the entire width of the valley floor. We have little exact information regarding the climate, but the distribution of the vegetation shows that the basal region is fairly dry, that rainfall increases and that temperature decreases with latitude, sufficient to allow distinct regions to develop.

Little is known with certainty of the geographical history of the islands. There are indications of a late submergence, whereby Santa Clara was detached from Masatierra; the strait, 1.5 km. wide, is very shallow (20-30 m., perhaps less). It is probable that this submergence included the western part of the main island. Dead land shells were found embedded in sand both here and on Santa Clara, but no living shells, which can hardly be expected from these desert-like places. Before the submergence the climate was more humid and the vegetation richer.

*The flora.* Two circumstances affecting the history of the flora should be considered: that the Glacial Period had little influence on the insular flora, and that the combination of rainfall and temperature is more favorable than anywhere on the opposite coast, so that the character of these islands as a refuge seems quite natural. The total number of indigenous vascular plants is 195 (some of these doubtful in this respect); of the 143 phanerogams 98 (69%, 10 endemic genera) are endemic, of the 52 pteridophytes 18 (34.6%, 1 endemic genus). The richer forest flora in Masatierra, the presence of an Alpine flora in Masafuera and the numerous examples of vicarism explain that only ⅓ of the vascular plants are found on both islands (27 phanerogams and 36 ferns). There is an accumulation of isolated types, either without any relatives at all or allied to species or genera belonging to New Zealand, Oceania, Hawaii, etc., the former exemplified by the arboreous genera of *Compositae* and *Umbelliferae, Lactoris* (monot. family), *Thyrsopteris*, etc., the latter in such genera as *Cladium, Carex, Santalum* (*S. fernandezianum*, extinct), *Peperomia, Boehmeria, Fagara, Halorrhagis, Coprosma, Plantago, Arthropteris, Blechnum*, etc. Together they belong to the Old Oceanic element of ENGLER. A smaller group with tropical Andine affinities is represented by the endemic genera *Juania* (a palm), *Selkirkia* (*Borag.*) and *Cuminia* (*Labiat.*), and by the endemic arborescent *Nicotiana*, and *Berberis*. As could be expected, the largest element is Chilean, though the species largely are endemic and as a rule very distinct: *Rhaphithamnus* (*Verben.*), *Pernettya, Ugni, Myrceugenia, Azara, Gunnera, Escallonia, Colletia, Drimys, Chusquea, Hesperogreigia* and *Ochagavia* (*Bromel.*). Finally, there is a considerable Subantarctic-Magellanian element in Masafuera, the majority of species non-endemic.

*Principal plant communities.* The humid sections of Masatierra were formerly densely forested from the coast to the highest ridges, leaving only the steepest rock walls and narrowest crests bare of trees, but the outer part of the valley floors and the lower slopes are now destitute of forest, which, in a more or less virgin state, is confined to the inner recesses of the valleys and the higher slopes; elsewhere, it has become replaced by weeds, several of them noxious, particularly *Aristotelia maqui*, which forms impenetrable thickets in most valleys, and the recently introduced *Rubus ulmifolius*. The indigenous "forest" is evergreen, subtropical-temperate, formed mainly by *Myrceugenia fernandeziana*, as a rule accompanied by *Fagara mayu* (taller, to 20 m. and more), an endemic variety of *Drimys Winteri, Coprosma pyrifolia*, and *Sophara fernandeziana*. Woody climbers are absent, but two winding ferns, *Arthropteris altescandens* and *Blechnum Schottii*, are common. Epiphytic ferns, bryophtes and foliaceous lichens are abundant. In the undergrowth, tree ferns (*Dicksonia Berteroana* and *Blechnum cycadifolium*) are scattered, as is the giant *Gunnera peltata*, which becomes abundant around the waterfalls in company with large clumps of *Cladium scirpoideum*. Stands of *Boehmeria excelsa* follow the streams. The ground is covered with fallen trunks and vegetable litter, and, where there is sufficient light, with thick carpets of ferns and mosses. The field strata are mainly composed of large-fronded ferns (*Lophosoria quadripinnata, Dryopteris inaequalifolia, Pteris* species, etc.), herbs being few (*Uncinia Douglasii, Carex Berteroniana*). The montane forest, above some 350-400 m., is less monotonous; additional tree species appear, such as *Rhaphithamnus venustus, Coprosma Hookeri, Azara fernandeziana* (*Flacourt.*) and the palm *Juania australis*, and the rosette trees make their appearance with *Dendroseris micrantha* (*Comp.*). Large ferns are abundant, the most notable being *Thyrsopteris elegans*. A rare and most interesting low shrub is *Lactoris fernandeziana*. Cryptogams, among these many *Hymenophyllaceae*, luxuriate, and mosses hang in festoons from the branches. The fog zone is characterized by nearly pure stands of *Dicksonia*.

In Masafuera, the closed forest is confined to

a belt between approximately 300 and 700 m. It is of the same general type as in Masatierra, but drier and formed by *Myrceugenia Schulzei* as dominant, mixed with *Drimys, Coprosma pyrifolia, Rhaphithamnus* and *Fagara externa.* Groves or scattered trees of *Drimys* and *Coprosma* are found as high as 900 or occasionally 1,000 m. Most of the species mentioned above for Masatierra are absent, or represented by vicarious species, such as *Sophara masafuerana, Dendroseris virgata* and *Gunnera Masafuerae.* The cryptogamic flora is less rich. The island is reported to have been much more wooded in former ages. The interior of the deepest canyons, which have been cut back almost right through the island, has retained a luxuriant flora of small trees, herbs and ferns which clothe the precipitous walls from top to bottom.

In Masatierra, where the forest dissolves at the foot of the vertical cliffs or over the narrow ridges, a most remarkable community has developed, an *Eryngium-Robinson* scrub. The dominant life form is the rosette or tuft tree of candelabrum type. The leading genera are *Robinsonia (Comp.), Eryngium* and *Dendroseris, Robinsonia gayana, Eryngium bupleuroides,* and *Dendroseris micrantha* and *pinnata* being the leading species. Much rarer are the monotypic *Centaurodendron* and *Rhetinodendron (Comp.), Selkirkia* and the remarkable arboreous *Plantago fernandezia.* On ledges, where more soil has accumulated, single forest trees find a foothold and of the large ferns *Blechnum cycadifolium* is common. Several other small trees and shrubs are members of the scrub community, as *Berberis corymbosa, Cuminia* (2 sp.), *Escallonia Callcottiae* and *Pernettya rigida.* The hanging *Bromus fernandezianus* is a common grass of these localities. The more or less dense cover of low shrubs, open on the lower, closed and entangled on the high humid ridges, and dominated by *Pernettya* and *Robinsonia Gayana* is an impoverished state of the *Eryngium-Robinsonia* scrub. Other common species are *Escallonia, Halorrhagis masatierrana, Wahlenbergia* spp., *Erigeron fruticosus* and *Ugni Selkirkii;* of herbs and grasses *Libertia formosa, Danthonica collina,* a.o. A characteristic feature of the perpendicular rock faces is *Ochagavia elegans.* Rock mosses and lichens are plentiful.

In Masafuera the scrub communities are little more than suggested along the edges and upper ledges of the ravines. All of the species mentioned, with the exception of *Pernettya, Libertia, Bromus* and *Blechnum* are absent, and the rosette trees are represented by 1 sp. of *Robinsonia* and 2 of *Dendroseris,* all endemic in Masafuera.

*Grass heath,* with stony patches of shrubs, covers the treeless western section of Masatierra and the entire basal region of Masafuera, with the exception of the narrow, well-watered gorges. The principal grasses are densely caespitose, perennial and xerophytic species; *Piptochaetium laevissimum* is dominant in both islands, accompanied by *Stipa fernandeziana* and *Chaetotropis imberbis,* in Masatierra also by the much more local *Chaetotropis chilensis, Danthonia collina,* and *Piptochaetium bicolor.* Near the sea *Scirpus nodosus* and *Spergularia confertiflora* are not uncommon. Of shrubs, *Pernettya* is found in both islands, in Masatierra also *Escallonia, Halorrhagis masatierrana,* and *Margyricarpus digynus,* but there are two other *Halorrhagis* in Masafuera. In this island the treeless section is much more invaded by weeds, above all *Avena barbata, Rumex acetosella* and *Acaena argentea.*

The coast cliffs in a number of places in Masatierra and Santa Clara harbor scattered specimens of *Dendroseris litoralis* and *pruinata;* the table-land of Santa Clara has few if any indigenous herbs or grasses, but is inhabited by numerous annual weeds.

The shores offer few places where closed associations of halophytes find suitable stations; mostly they are confined to crevices and caves near sea level. *Asplenium obliquum, Adiantum chilense, Lobelia anceps* and *Spergularia confertiflora* are not uncommon, *Apium fernandezianum* and *Wahlenbergia Berteroi* are confined to Masatierra, *Erigeron rupicola,* the peculiar *Eryngium sarcophyllum* and *Wahlenbergia Masafuerae* to Masafuera. Fragments of a salt-meadow are observed here and there, including *Scirpus cernuus, Salicornia fruticosa* and *Tetragonia expansa.*

*Vegetation above the forest in Masafuera.* The subalpine heath is a complex of *Anthoxanthum odoratum* meadow with copious *Rumex acetosella,* extensive fernbeds, mainly of *Lophosoria,* and in more humid situations very large patches of low-growing *Gunnera Masafuerae. Dendroseris virgata* occurs in the heath in scattered groups, and in the southern half of the highland, on the slopes of Mt. Inocentes, it forms an impenetrable fern forest between 750 and 1,200 m. The ground is formed of the prostrate stem-bases and decaying matter, and is almost destitute of plants.

*The Alpine heath.* Along the backbone of the ridges, from about 900-1,000 m., alpine plants begin to appear, and above 1,200 m. extending to the summit, are dense mats of trailing herbs and shrubs, tufted perennials, and cushion plants, reproducing the Magellanian heath. *Abrotanella (Compos.), Acaena, Galium, Luzula* and *Erigeron* are represented by endemic species, but the other are well known inhabitants of the Falkland Islands or Tierra del Fuego, such as *Lycopodium magellanicum, Oreobolus obtusangulus, Carex Banksii, Uncinia phleoides* and *tenuis, Rubus geoides, Myrteola nummularia, Empetrum rubrum, Nertera depressa,* and *Lagenophora Hariotii.*

The *freshwater flora* is extremely poor. There are no lakes, and the streams are small and generally rapid. *Scirpus cernuus, Heleocharis maculosa, Parietaria debilis, Cardamine flaccida* and *Lobelia anceps* may be mentioned.

*Influence of man.* Human traffic has altered the flora profoundly; unintentionally introduced weeds are as many as the indigenous species, and several garden plants have become naturalized. The early introduction of goats has been disastrous, here as elsewhere, and they are still plentiful in Masafuera. Cattle were brought to Masatierra with the settlers, most of the open western country is grazed, much of the priceless forest has been cut for fuel and lumber, and there has been a trade in palm wood and living tree-ferns. The sandalwood was almost extinct before 1800. The convict settlements in Masafuera, which now remain uninhabited, have been fatal to the plant world. Some years ago the islands were declared a national park, but little has been done to enforce the regula-

tions. The colony of fishermen in Cumberland bay depends on "langosta" fishing, a large Decapode (*Jasus Lalandei*), exported to Valparaiso in a living state or canned. Agriculture is confined to a few small wheat and barley fields, and potatoes. Peas and brown beans do well, as well as most of our common garden vegetables (turnips, onions, tomatoes, artichokes, cabbage, lettuce, cress, etc.). Fig and quince have become naturalized and give excellent fruit; peaches, apricots and cherries give indifferent results. Grapes were introduced early, but are little grown at present; orange and lemon have been tried without success. It is interesting that the papaya can be grown, but the fruit is small. The land available for gardening is quite restricted, unless terrace cultivation is introduced.

*THE DESVENTURADAS:* — San Ambrosio is situated about 800 km. W. of Chañaral. It is a high basalt block very much like Masafuera in appearance, about 3 km. E-W and 900 m. wide, and bordered by perpendicular cliffs; there is no beach. The table-land, 400-450 m. high, is intersected by numerous ravines, but not very deeply eroded. Landing is possible only on the north side and is always hazardous, and no scientist has visited the place.

San Felix, 16 km. farther west, is of about the same size as San Ambrosio, but much lower (ca. 180 m.) and of easier access. Attached to the south-east corner by a reef lies the small inaccessible rock Gonzales. The climate is very dry, but less so in the highland of San Ambrosio. The islands are not inhabited and very rarely visited. The earthquake in Chile in November, 1922, extended its effects to these islands, and there was a gas eruption on San Felix, killing most of the sea birds. Some guano accumulates on both islands.

The flora is as remarkable as it is poor. Nineteen phanerogams are known, belonging to 16 genera and 13 families. Three genera and 12 species are endemic; the genera are *Nesocaryum* (*Borag.*, monotypic with Andine affinity), *Lycapsus* (*Comp.*, monotypic and isolated, but probably of American affinity) and *Thamnoseris* (*Comp.*, dwarf rosette trees, 2 very closely related species, one on each island, and probably nearest to *Dendroseris* of Juan Fernandez). Several species belong to halophilous and nitrophilous genera (*Parietaria, Atriplex, Suaeda, Tetragonia, Lepidium, Frankenia*); they are endemic except *Spergularia confertiflora,* which grows on Juan Fernandez.

The flora is, perhaps with the exception of *Thamnoseris,* of American origin. It is undoubtedly a rest flora, which has shared the history of the Fernandezian.

The vegetation is open, quite desert-like in San Felix, where only 7 species have been found, 3 of these being also known from San Ambrosio.

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**WM. C. DARRAH: A Geological Sketch of Central America and the Antilles:** — The area embracing southern Mexico, Central America and the Antilles presents the most intricate geological history and complex physical geography known. The entire region has been unstable since early Mesozoic times. The seas have flowed across Tehuantepec and Panama, the islands of the Antilles have been united and again isolated, Barbados submerged 10,000 feet during the Miocene to emerge again in the succeeding Pliocene. Neighboring South America was extensively inundated and emerged during the earlier Pliocene. Thus at the outset we recognize that continuity between North America and South America has not been permanent or geologically ancient.

Conventionally this geographic province is subdivided into three regions: Mexico proper, Central America, and the Archipelago of the Antilles.

The term Central America as here used includes southern Mexico and the territory south to the Isthmus of Panama. The political subdivisions are: the republics of Guatemala, Honduras, Salvador, Costa Rica, Nicaragua, and Panama, and the colony of British Honduras. Briefly then Central America is that portion of the American continents between the Isthmus of Tehuantepec and the Isthmus of Panama.

Central America is not a structural unit (*Cf.* p. 318) — the mountains of the northern portion trending east-west, whereas those of the southern part trend north-east south-west. The mountain ranges of Central America belong to the *Antillean* system in distinction to the Andean system. Submarine ranges extend across the Caribbean, one between Honduras and the Sierra Maestra in Cuba and the other between C. Gracías a Dios and Jamaica. The Greater Antilles (Cuba, Haiti, San Domingo, and Porto Rico) were connected during the Oligocene not only among themselves but also probably to the North American mainland by way of southern Mexico.

Porto Rico is the easternmost of this chain extending for more than a thousand miles. It is at the same time the northernmost of a chain of smaller islands extending southward for more than 600 miles to the coast of South America.

The Brownsons Deep (27,000′) is located off the north coast of Porto Rico.

The Lesser Antilles are two north-south trending island series, bending westward. The inner (westward) arc are the exposed volcanic peaks of an extensive submerged ridge, and the outer (eastward) group are geologically older limestone-capped islands. From the standpoint of origin, Barbados and Trinidad are excluded from these because they are genetically parts of the South American continent. Trinidad, separated by only 6 miles from the east coast of Venezuela, is famous for its Pitch or asphalt lake which owes its origin to the evaporation of the volatile constituents of petroleum seepages.

Mexico geographically and geologically is an integral part of the North American continent. The region is a great elevated plateau about 8000 feet high in the state of Mexico but sloping generally from south to north and from west to east. It is open in the direction of the United States. The plateau is delimited by a double chain of mountains on the maritime flanks. These mountain ranges join at La Junta southeast of Puebla. A narrow fringe of lowlands extends from the foothills to the sea. The Yucatán Peninsula is a great plain underlain

by limestones of recent geological origin. This great plateau is the eroded remnant of an intensely folded region, now partly covered by detritic sediments and volcanic deposits. The double chain of mountains are continuations of the American Basin Range. Lower California, a political subdivision of Mexico, is an extension of the American Coast Range.

*Stratigraphy.* — Archaean or early Paleozoic granitic and schistose rocks occur in Guatemala, British Honduras, and Costa Rica. In Guatemala these rocks occur in the ancient east-west ridges and are overlain by carboniferous limestones containing characteristic marine invertebrate fossils. For all of Middle and Central America little is known of Paleozoic history.

The Mesozoic is better represented but by scattered and isolated deposits. Sandstones and clays of Triassic and clays with fossil plants have been found in Mexico and Honduras. Larger areas of Cretaceous clay, sandstones, conglomerates, and limestones have been mapped in Guatemala, Honduras, and Costa Rica.

Cenozoic rocks are widespread and form the exposed deposits of the major land surfaces. The earlier Cenozoic deposits consist of Eocene and Oligocene sands and clays evidently laid down in shallow water near shore. The upper younger Cenozoic includes Pliocene also deposited in shallow water.

*Deformation.* — The entire Central American-Antillean region was involved in the general subsidence of the Gulf of Mexico during the Cretaceous and Cenozoic and in the severe extensive folding (mountain-making) of the Jurassic and Lower Cretaceous.

All of the strata up to and including the Oligocene sedimentary deposits were deformed by the structural folding. The Pliocene strata, with few local exceptions, are undisturbed. The Miocene, therefore, appears to have been a period of widespread uplift—presumably throughout the Caribbean region.

*Discontinuity of the Americas.* — The two continents were probably brought together by the Isthmus of Panama during the Miocene. Until Cenozoic times a sea portal separated North America and South America. The lands of Panama came into existence in the late Cretaceous or early Eocene. Panama was exposed land throughout the Cenozoic. Limited marginal sedimentary deposits were accumulated.

During the Eocene, much of Central America was submerged, cutting off land communication between the continental land masses, but opening a pathway of marine migration from the Atlantic to the Pacific.

Thus there are two important severances of land connection between the continents—an older Mesozoic preceding the origin and dispersal of the angiosperms and a later Miocene-lower Pliocene which transgressed the early Cenozoic connection. Since Pliocene times continuity has been uninterrupted.

It is noteworthy that the Cenozoic faunas confirm these interrupted connections. The Pliocene faunas of both continents show an intermingling of types whereas the earlier faunas are distinct and show remarkable endemism. Since Pliocene times—that is, since the Americas have been connected—the two faunas have merged in Mexico where the complex is mixed but predominately North American.

*Volcanoes.* — Commencing almost at the boundary between the United States and Mexico, there occurs a chain of volcanoes which extends almost unbroken until it reaches the southern tip of South America. In Central America these volcanoes stand along the west coast. The volcanic deposits are extensive and deep. Active eruption began near the close of the Cretaceous and still continues intermittently.

The eruptive lavas are mostly andesitic and basaltic, but with some rhyolite, trachyte, and local phonolites.

Throughout the entire Central American-Antillean region there are active and recently quiescent volcanoes. The regional instability is indicated by the magnitude of changes within historical times.

Popular curiosity and indeed scientific interest attends the birth in 1943 of Paracutín, a young volcano (in the state of Michoacán) about 200 airline miles west of Mexico City. This cinder cone now more than 2000 feet high began as a small fissure in a maize field. Within a week a cone 550 feet high had been accumulated. Lava and incandescent gases are ejected. This is by no means a novel occurrence in Central America. Jorullo was born in 1749, Izalco in 1770, Las Pilas in 1853, and Illipango in 1880.

The sudden origin of Jorullo was perhaps the most sensational of all. In June 1759 an earthquake lasting more than 50 days shook an area of fertile table land between Colima and Mexico City. On September 28, 1759 at night, a tract of land almost four square miles in extent covered with cotton, cane, and indigo, was heaved to a rounded dome with a central height of about 500 feet. Thousands of small cones, 6 to 10 feet in height appeared on the surface ejecting boiling mud and incandescent gases. Water from dammed streams gradually reached the cones and a violent explosion with electrical discharge followed the decomposition of the water. Six large earth masses were lifted 600 to 1500 feet high. Continuous eruptions occurred until 1760, thereafter with diminishing frequence. Today Jorullo is 4260 feet high.

*Climatic Change.* — In closing, a brief allusion to possible changes of climate within historical time should be made. The ruins of Mayan civilization have provided rich sources of information. The agricultural attainments of the Mayan people—to say nothing of their technological developments—have led many archeologists, geographers, and paleobotanists to investigate vegetational changes by the methods of dendrochronology, pollen analysis, and micropaleontology. The most fruitful investigations have been in Yucatán and Guatemala.

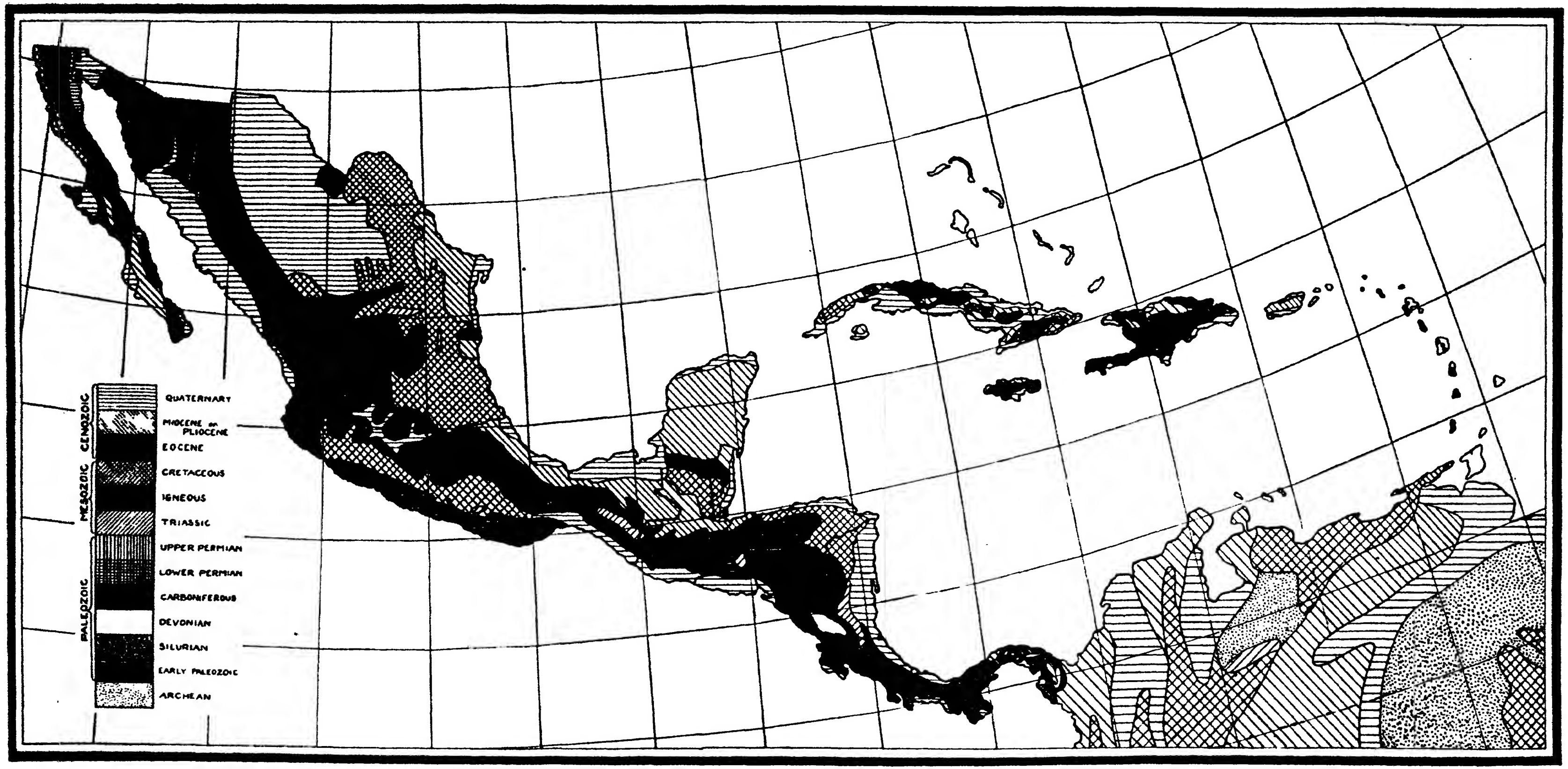
*Summary.* — The phytogeographic implications of the diverse geologic features which characterize the architecture of Central America and the Antilles are:

(1) The intermingling of North and South American floral elements of four historical sequences: Cretaceous, Early Eocene, Miocene, and Plio-Pleistocene. This last named is continuing at the present.

(2) The existence of relict elements especially cool temperate, of North American origin on the higher altitudes. These are descendants of Miocene and/or older Cenozoic floras.

(3) A geologically young and meager flora being developed on the members of the Antillean archipelago.

(4) Multiformity of topography—rugged in-




Geological Map of Central America. — A generalized map showing major features of the historical geology of the region. Comparatively little is known of the geology of Honduras, Costa Rica, Nicaragua and parts of Mexico. As a result new work may alter the conception adopted here. As in South America the age of the ancient igneous complex is disputed—either early Paleozoic or Pre-Cambrian. The small Permian outcrops in Mexico are associated with Triassic deposits.

accessible mountains and volcanoes, alpine peaks, inundated lowlands, and varied soils.

(5) Since the entire province extends within the tropics and semitropics extremes in topography, rainfall, temperature, soil, and floral distribution are determined by geological structures.

(6) Grand scale changes in elevation, soil drainage, and climate have occurred within recent geologic times—continuing in the historical era. Prehistoric human occupance of large areas in Central America are well known.

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ROBERT G. STONE: **Climatology and Meteorology:** — The major ecological types of vegetation are geographically segregated over the continents in a pattern which shows quite obviously that this aspect of plant life is most certainly largely an expression of varying climatic factors. As soon as this "correlation" is analyzed in more detail, however, especially from the physiological and historical points of view, it becomes a most complex scientific problem which seems almost unsolvable in a strictly analytical form under present methods. The problem has been attacked empirically by choosing climatic isolines (isotherms, for example) corresponding to vegetation boundaries, and ecologically by detailed field surveys to correlate the local environment with the plant association. Unfortunately the latter work tends to discredit the former, for the effects of soil, human interference, competition of species, migration, and historical accidents play such a large role that simple climatic interpretations of the limits of vegetation types have turned out to be illusory. Thus the special "systems" of climates designed to correspond to vegetation zones merely describe the geography of vegetation in arbitrary meteorological elements or units and fail to contribute much to real understanding of either the climate as such or of the manner in which the atmosphere influences the form and distribution of plant life. The general botanist wishes to know the elementary facts of the seasonal and geographical distribution of rainfall and temperature over Latin America, which facts can be grasped without special understanding of meteorology. The research botanists who work on problems of distribution or ecology should, however, obtain the collaboration of a professional meteorologist (—the American Geophysical Union will assist scientists in obtaining the best advice). The sources of information on meteorology are scattered and poorly compiled; bibliographic aids and general works are inadequate for specialized applications.

*OBSERVATIONAL MATERIAL:* — The scientific description and analysis of climate requires in the first place a sufficient accumulation of regular instrumental observations made with standard equipment and instructions. (Subjective, or rather, non-instrumental, observations also may be of great auxiliary value in interpreting the instrumental results.) Since 1871 standards for the taking of observations have been set up by international agreement but both private and official weather observers in each country still retain certain customs and instruments which differ more or less significantly from those elsewhere. Whenever observations made in different places, especially different countries, are to be compared or combined, efforts should be made to discover whether there were any such differences in the way the observations were taken and whether they are of a nature that would seriously affect the comparisons of the data for the intended purposes. There are numerous sources of error in observations and the reports of even the best weather observatories are not entirely free of them. It is important to restrict refined quantitative comparisons of climates of different stations to data based on averages of over 7 years in case of temperature and over 20 years in case of rainfall. Owing to long quasi-periodic and erratic fluctuations from year to year and from decade to decade, such comparisons should also be based on averages covering approximately the *same* calendar years. Otherwise, one cannot be certain that apparent differences are real. The critical evaluation of the reliability of the raw and summarized meteorological data is often a more important and difficult matter than the biologist realizes; it will be well therefore for the latter to seek the advice of competent professional meteorologists and climatologists in the selection and interpretation of climatological data. The general standard of observations has been and still is dubious in those American countries which have not had a particularly well-organized governmental weather service. Some information as to the character of the observations can often be had conveniently from the governmental weather services by correspondence, by visit, or by consultation of their published reports. But for the private stations in countries lacking official services, it is usually impossible to select reliable data without actually visiting the stations themselves. The writer can say from his own experience that for tropical America much of the published data is grossly erroneous for one reason or another; for some purposes this is not serious, but at least one should use caution in accepting anomalous appearing large local peculiarities as real or significant. For the whole of the Americas as a unit the data is not homogeneous, but within any one large country, such as U. S. A., Canada, Brazil, Argentina, etc., the data of the government weather services are relatively standard in character.

*LITERATURE:* — The vast literature on Latin American meteorology is, alas, largely fragmentary and trivial. Both as a summary of existing knowledge and as a bibliographic guide the great "Handbuch der Klimatologie," edited by W. KÖPPEN and R. GEIGER, will serve most needs. Its separate volumes on Mexico, West Indies, Central America, and South America, respectively, should always be consulted

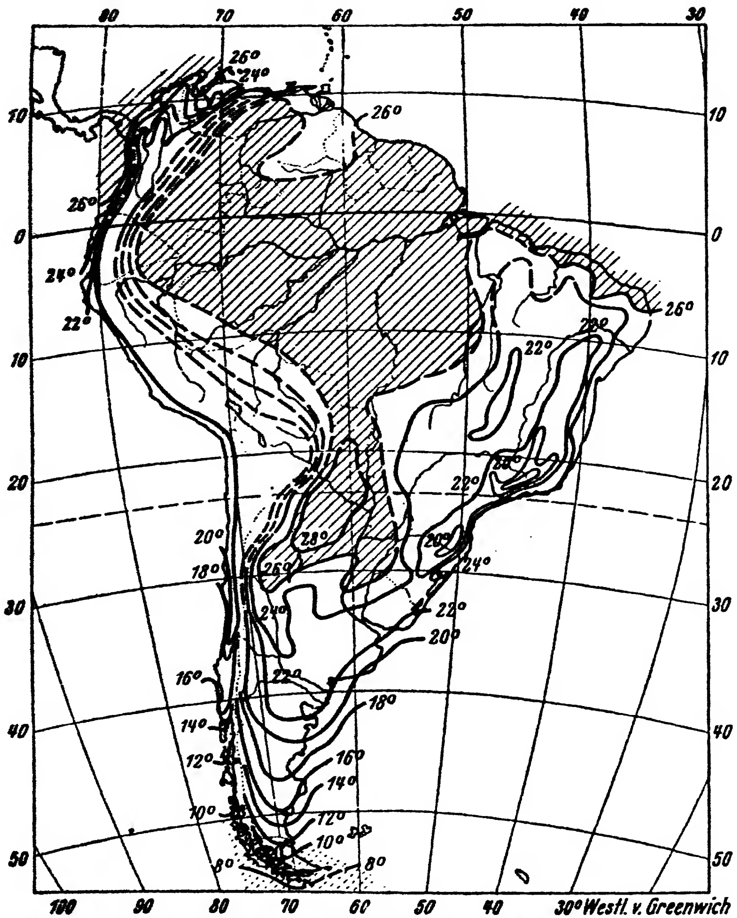


**Figure 1.** — January Mean Actual Temperature Distribution in °C. (from Köppen-Geiger, *op. cit.*). The isotherms are omitted in the high Andes to avoid crowding of the lines. Some January means for high stations: Calama, Chile (2260 m) 16.9°; La Paz, Bol. (3658 m) 10.2°; Cerro do Pasco, Peru (4350 m) 6.7°; El Misti, Peru (5850 m) —6.0°; Quito (2850 m) 12.6°; Bogotá (2660 m) 14.4°.

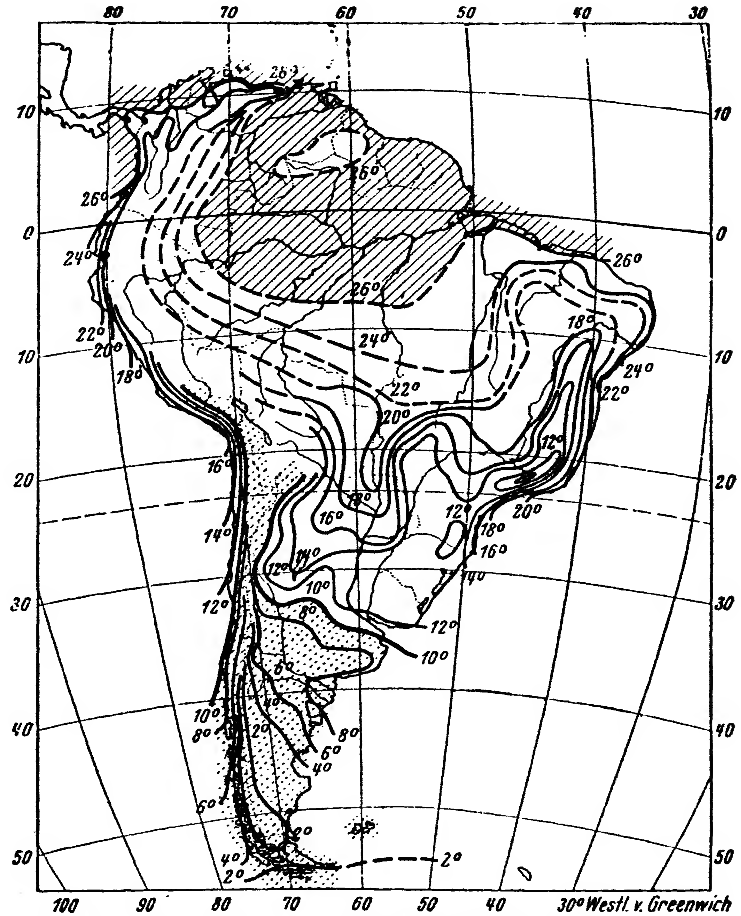


**Figure 2.** — July Mean Actual Temperature Distribution (see Fig. 1). July means: Calama, 8.0°; La Paz, 6.4°; Cerro do Pasco, 4.7°; El Misti, —9.5°; Quito, 3.4°; Bogotá, 14.0°.

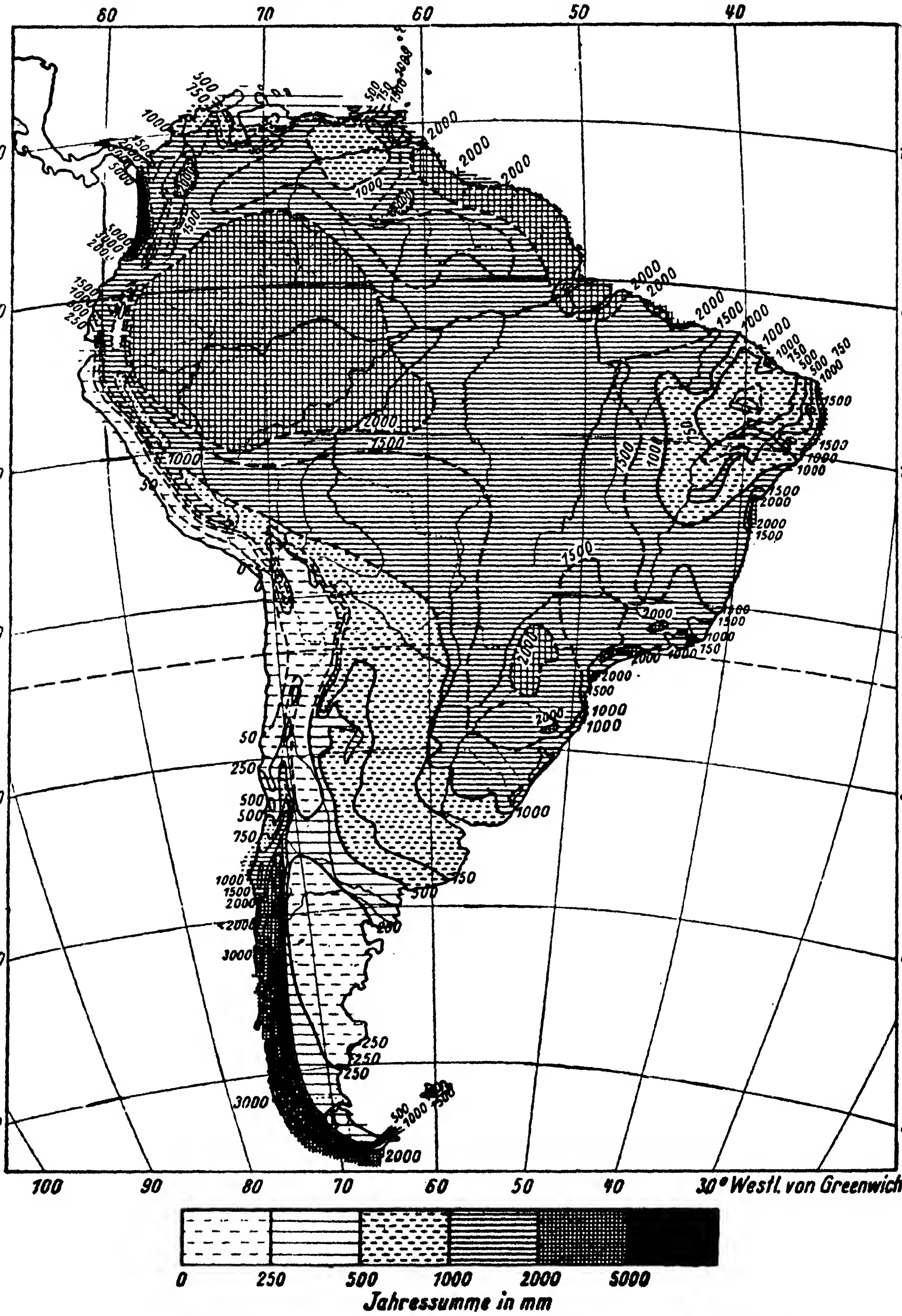


FIGURE 3.—Mean Annual Precipitation, in millimeters (from KÖPPEN-GEIGER, *op. cit.*).

first. They contain extensive tables, maps, and references. Brief general descriptions of the climates appear in many geographical works, but they are not entirely reliable. KENDREW's "Climates of the Continents" is useful. For detail, the publications of the official weather bureaus of Mexico, Brazil, Argentina, Chile, Uruguay, and Peru are excellent. Special bibliographies will be found in *U. S. Monthly Weather Review Supplement No. 18* (to 1921), in the files of *Ibero-Amerikanisches Archiv*, and *Das Geographische Jahrbuch*, but the best information from these have been selected and combined in the KÖPPEN-GEIGER "Handbuch." The excellent *Current Geographical Publications*, published by the American Geographical Society monthly lists all new literature as it appears.

The published source material on Latin American climate is abundant only in the libraries of the official weather services of the leading

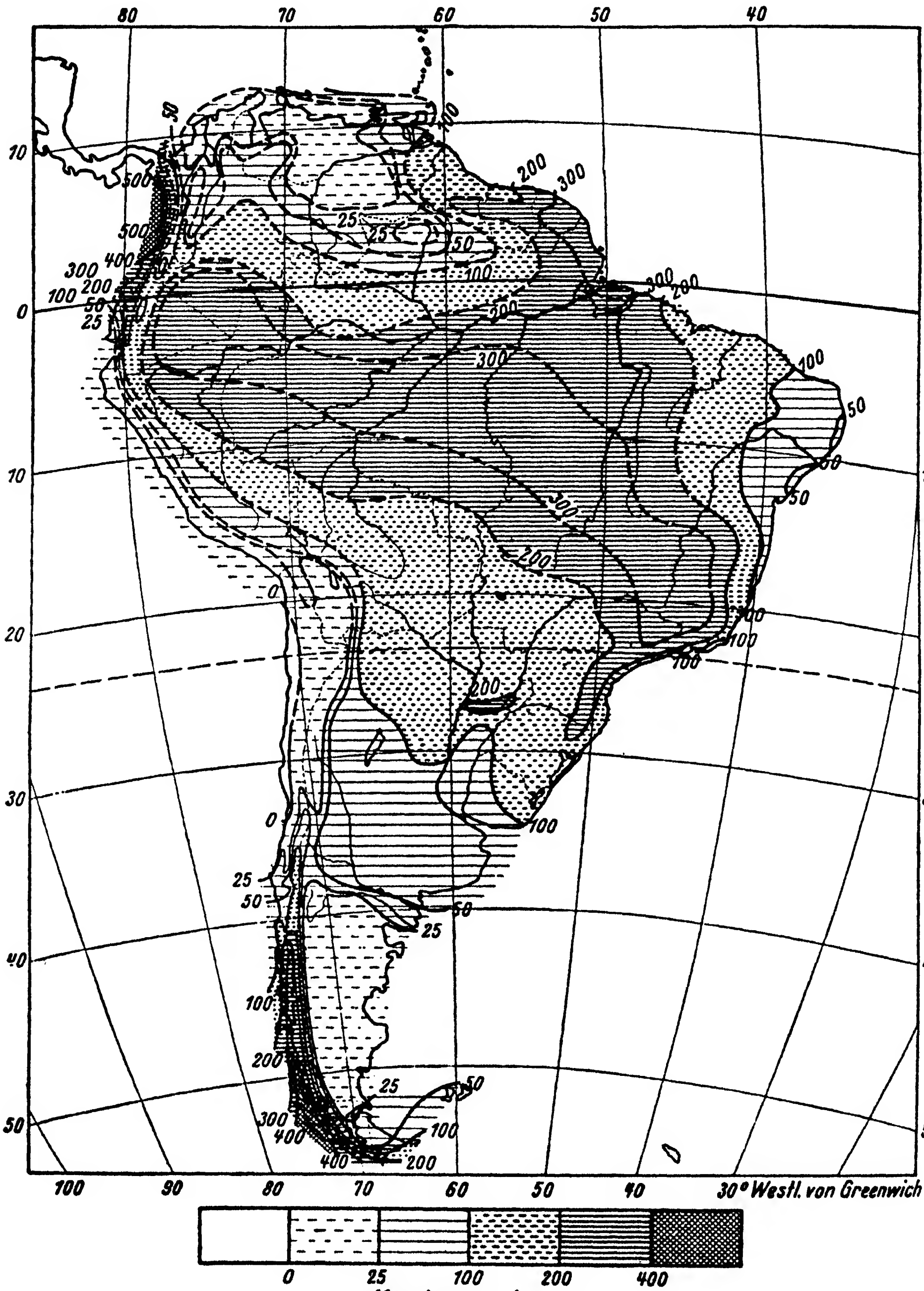


FIGURE 4. — Mean January Precipitation, in millimeters.

countries. Also the Library of Congress, Blue Hill Meteorological Observatory of Harvard University, the American Geographical Society (N. Y.), and libraries of the Universities of California, Chicago, Michigan, Yale, Wisconsin, and Pennsylvania have rather large collections.

A short list of references is appended to this article.

*DISTRIBUTION OF THE ELEMENTS:* — The climate is most simply though not completely described as the average weather that may be expected. Each atmospheric element is measured separately by physical means, but the biological significance of each is measurable only in terms of effects on organisms. It happens that only rainfall totals and temperatures are observed at the majority of stations. Fortunately, these are the two most important climatic elements influencing the large-scale distribution of types of vegetation. A systematic variation

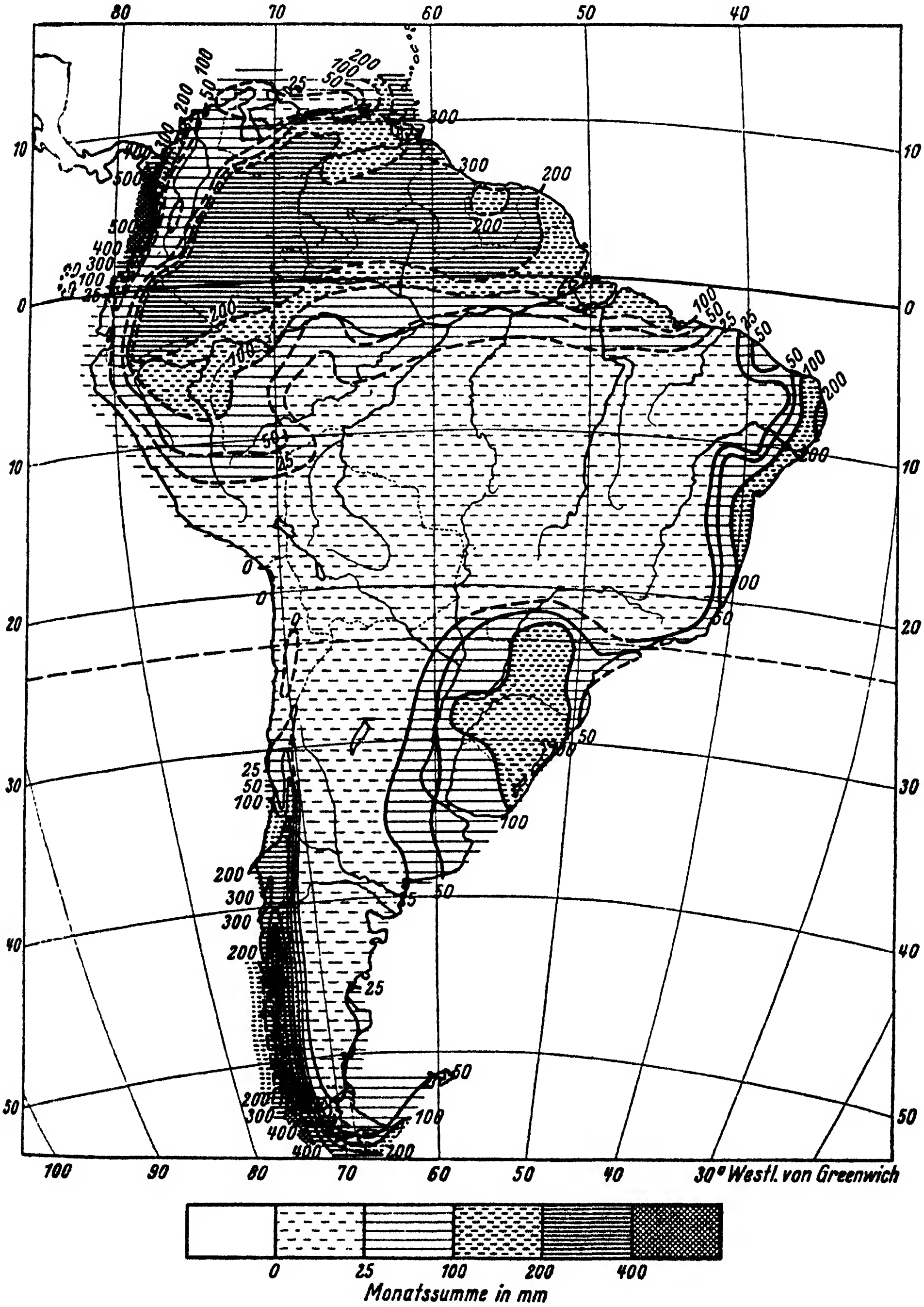


FIGURE 5. — Mean July Precipitation, in millimeters.

of temperature with season and with latitude is caused by the varying duration and altitude of the sun above the horizon. Sunlight, though also an essential element for plant existence, is prevalent enough over most of Latin America so that it does not in itself become a limiting factor for photosynthesis except perhaps on always-clouded mountain tops and in cloudy extreme southern Chile.

*Temperature:* We show herewith maps of the mean *actual* temperatures over South America in January and July. These are approximately the warmest and coldest months in the latitudes south of 25° S.; in lower latitudes, however, the extremes may come at other times, notably in the driest and rainiest months respectively, because here the small seasonal variation in the sun's position is outweighed by the effects of

cloudiness. The mean temperatures at lower elevations in low latitudes are relatively high in all months; at higher elevations the normal decrease of temperature with height causes pseudo-temperate conditions, definitely distinct from true middle-latitude climates in having the small annual range in solar radiation and temperature characteristic of the tropics. The maps are too small to show adequately the actual temperatures on the mountains. The variation with elevation is rather regular in any one district, however, and useful interpolations or could reach directly into lower latitudes without rapid warming. The summer heating of western Argentina is quite pronounced due to the westerly winds descending the Andes (foehn; absence of clouds; solar heating).

There is considerable day to day variation of temperatures in latitudes greater than 15° in winter and 35° in summer, due to the alternation of warm and cool air masses with passages of cyclones and anticyclones. In winter cold air masses from higher latitudes occasionally burst into very low latitudes, causing brief spells of

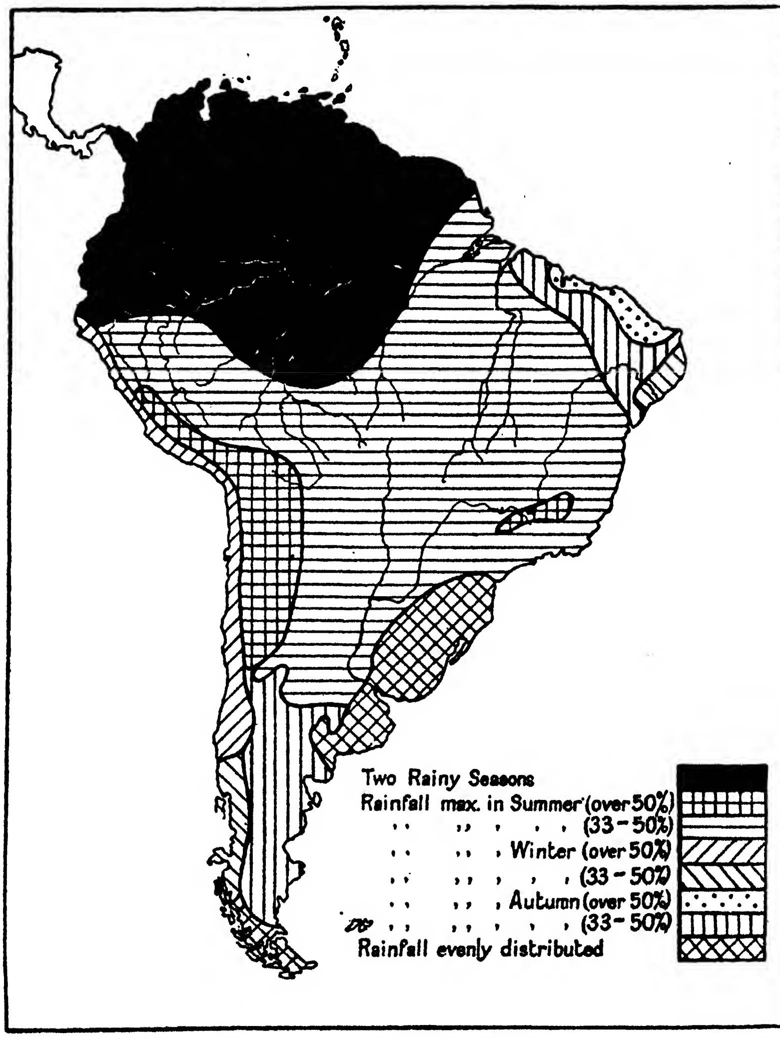


FIGURE 6. — Seasonal Distribution of Rainfall in South America (after Voss, from KENDREW'S Climates of the Continents, ed. 3).

extrapolations can often be made between stations with comparable exposure. The freezing isotherm lies around 15,000-17,000 feet in the tropics, and descends gradually to about 2,000 feet (in winter) in Tierra del Fuego. The middle and higher latitudes of South America are warmer and have a smaller annual range of temperature than corresponding latitudes of North America and Asia, owing to the narrowness of the continent and to the lack of a landbridge with Antarctica over which polar air near-freezing temperatures (chiefly in early morning hours) almost to the Amazon and on the Mexican and Guatemalan plateaus. These cold spells in the tropics are not revealed in the average temperatures but they are of biological importance.

*Rainfall:* Four maps are reproduced herewith showing for South America (a) average annual rainfall totals, (b) January, and (c) July average totals, and (d) the types of seasonal distribution. The annual rainfall total ex-

presses a potential for the development of the vegetation, but the effectiveness or availability of rain for plant growth may be greatly limited by percolation, evaporation, run-off, and irregular distribution in time. In particular, the evaporation is great where the temperature is high. The intervention of a long dry season or many dry spells requires special ecological adaptations, regardless of the total annual rainfall. Thus the seasonal distribution of rain together with the associated temperature regime provide the most significant simple description of the climate. The months of July and January are not necessarily most representative of winter and summer nor of wet or dry seasons in any one part of the continent, but they do show the very general tendency for predominance of winter rain in the higher latitudes and predominance of summer rain in the subtropical regions of the continents. The summer rain is mainly showery and intense while that of winter is partly showery and partly steady, less intense but of longer duration than in summer. Figure 6 is a somewhat more precise description of the seasonal rainfall regimes, but an examination of the curves of rain month by month through the year for many individual stations will reveal a high degree of peculiarity in each district, which makes all generalizations of limited value for practical purposes. The equatorial sections though rainy in all months have a tendency toward two rainfall maxima in the year, but in Latin America few places have the ideal equatorial scheme described in text books and often found in Africa. The Caribbean area has the normal "high-sun" rains in spring but the second rainy season generally spreads out from summer through the autumn (even into December and mid-winter on mountainous east slopes), while some places have only one long rainy season centered through the summer months. January to March is very dry nearly everywhere in this region. In South America the double-maximum equatorial type rainfall regime appears clearly only in the northwest. The eastern Amazon area has one long excessively rainy period between October and June, but no months are really dry. Most of the vast interior region from 3° S. to Patagonia has a more or less distinct spring or summer rainy season and a winter dry season. Along the whole east coast as far north as Cape S. Roque and along the Chilean coast south of 30° S. the rains are well distributed through the year. Latin America is poor in desert areas. The west coast belt from 5° to 30° S. is a true desert, the rare rains falling in winter. Likewise much of Lower California and northern Mexico is desert. Marginal to these are extensive areas of semi-desert (steppe desert): in central and northern Mexico, northwest Argentina, eastern Patagonia. Elsewhere in tropical America very "dry holes" in the rainshadows of mountain ranges, and some small flat islands and peninsulas, are found with cactus or thorn forest. The causes for these are various, but in general their climates have a regular rainy season, if only brief or light.

The details of local rainfall distribution are very complex, especially in the mountains and in the tropical zone, where large variations in the normal totals for a month or year may be expected over short distances. Small-scale maps cannot show this, but a sufficiently dense net of observation stations is lacking in most of Latin America in any case. It is, however, possible for an experienced meteorologist to make good estimates for many places lacking data, by interpolation using principles gained from study of detailed maps for similar climates having adequate data. In most of Central America and the West Indies the rainfall distribution is almost entirely controlled by topographic exposure to prevailing winds and by elevation. Detailed published rainfall maps of Martinique, Jamaica, Hispaniola, and Puerto Rico may be consulted for examples. The increase in rainfall with elevation is often 150% in 1,000 feet on steep windward slopes in the tropics; the maximum rain is not always on the highest point of the slope, however.

Snow is an annual occurrence in Argentina, Chile, Uruguay, Southern Brazil and Paraguay, the Plateau of Mexico, and on the tropical mountains above 13,000 feet, but the amounts are small outside of southern Chile and the high Andes of Chile.

*Relative humidity:* The observations of this element are very unreliable. Outside the desert and the semi-arid zones the average relative humidity is rather uniformly high (70-85%). Away from the coasts it varies considerably with the season, depending on the rainfall, and with time of day. Prevalent low clouds blow against the coastal hills of the desert coast of Chile and Peru, keeping them wet with mist much of the time although rain is rare.

*Cloudiness:* Data are few but in general indicate that east of the Andes .4 to .8 of the sky is covered on the average, being more in the rainy season and less in the dry. The rainy western slopes of southern Chile and Colombia, the desert shore of Chile and Peru, and all of Tierra del Fuego are exceptionally cloudy during the whole year. Likewise the northeastern (windward) slopes of the West Indies and Central America are cloudier than the southwestern slopes (leeward). The deserts average .1-.4 of the sky covered.

*Winds:* The general circulation of the atmosphere over the continents is described in standard works; it is the key to the meteorological explanation of the climates, but is beyond the scope of this article. High wind velocities may, however, be a matter of special consequence to plant life in some places: *e.g.*, the hurricanes of the West Indies; the strong sea-breezes and onshore winds along coasts; strong valley winds in the Andes; gales in Tierra del Fuego region and southern Chile and Patagonia; "Pamperos" (cold waves) of Argentina. The interior of Brazil has a high frequency of calms.

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ROBERT L. PENDLETON: **Some Important Soils of Central America:** — For the Netherlands Indies MOHR[1] has described the broad fundamental relationships between rainfall regime, parent materials, vegetative cover, ground water position, time during which the weathering processes have been proceeding, and the present and presumed ultimate character of the principal soil profiles. Similar relationships appear to hold true for the soils of equatorial America. In a region with as rough and diversified a topography as is Central America, and where widely divergent types and degrees of recent volcanic activity have been occurring, physical character and chemical composition of the parent rocks have been of great importance in determining the kinds of soil profiles which now exist.

*Climate.* — Since Central America lies across the trade wind belt, the eastern and northeastern coasts and exposures of the mountains receive much heavier rainfall, in places over 200 inches annually, while on the leeward coast the rainfall is of the order of 60 inches annually. In parts of Southwestern Costa Rica and Panama heavy precipitation caused by locally important southwestern winds has notably intensified soil weathering.

*Important Petrographical and Physiographical Regions and their Soils.* — (A) *Older volcanics and associated rocks:* Batholiths, now exposed as the granitic cores of certain of the mountain ranges in northern Honduras, northern Nicaragua, and in central and eastern Costa Rica, have deformed and metamorphosed acidic volcanic tuffs, breccias, limestones and other sedimentary rocks. (1) Where these rocks are exposed to only moderate rainfall, as in northern Honduras, moderately fertile brown clay loams carrying broad leafed forests have developed on the granites and limestones; on the acidic rocks are dark gray to black soils forested by pine.

The broad-leafed forests are usually kaiñgined for maize production, while the pines are seldom cut, except to improve the pasture. (2) On the leeward slopes, toward the Pacific Ocean, acidic tuffs and other, older metamorphosed volcanics have given rise to a relatively very shallow black clay soil. Though this soil has a rich black color, it is infertile to an astonishing degree. It readily assumes a finely granular structure during the long dry seasons, while when wet it is unusually sticky. This soil seems to offer very little possibility of use except for pastures, and even then its value is low. (3) Where the mountains are exposed to much heavier rainfall and the profiles are more mature, striking differences in natural vegetation are not apparent. The soils are not fertile: for tens of miles at intermediate elevations the tall dense tropical rain forest is unbroken by a single kaiñgin or other sign of human activity. In the General Valley, to the south of the Talamanca range, hills of metamorphic rocks and dissected terraces have been deeply weathered to senile, infertile reddish brown clays. (4) At greater elevations, a thousand meters or more, as in the Matagalpa highlands of Nicaragua, the metamorphic rocks are deeply weathered to light reddish brown clays. As with most profiles, where the soil is undisturbed, the color of the uppermost decimeter is considerably darkened by organic matter and the clay texture is frequently masked by mountain granulation. Much of the forest has been cleared for pasture; some coffee and vegetables are also produced. (5) Above 3,000 meters, on some relatively flat portions of the Talamanca mountains of Costa Rica, are peat bogs.

(B) *Small scattered basaltic extrusions* near Bluefields, in the eastern coastal plain, have weathered to deep friable red clays. These are kaiñgined for subsistence crops.

(C) *In northern British Honduras and neighboring Guatemala*, on the limestones are vast expanses of shallow reddish brown clay loams. While most of this soil is forested, in certain localities sugar cane and maize are important crops.

(D) *Old alluvial plains:* Of interest pedologically, yet practically useless agriculturally, is the vast mass of sediment carried out during earlier times by the Coco and Patuca rivers in northeastern Nicaragua and Honduras. Elevated roughly 20 meters above the present sea level, these materials have been exposed to heavy and nearly continuous rainfall for such a long time that the surface portions of these deposits have become extremely impoverished, and are now a light yellowish, very acid lixivium. In places, at least, the weathering process has reached the senile (true Buchanan) laterite stage. These soils normally carry short sparse grasses and diminutive sedges, with here and there considerable stands of Caribbean pine. Where ravines have cut back into this plain, the slopes which expose less drastically weathered sediments are occupied by shrubs and dwarfish broad-leafed trees.

At least two other similar elevated plains of deeply weathered alluvia have been reported: (1) The coastal plain of British Honduras, where the vegetation is similar to that of the Puerta Cabezas region, described above. (2) By contrast, for there are no pine on this plain, in western Panama, in the vicinity of David and on toward the Costa Rican boundary.

**(E)** ***Some important recent alluvial soils:*** **(1)** The Rio Grande, Escondito and other rivers in eastern Nicaragua rise almost entirely in the acidic tuff region on the eastern slopes of the Central Cordillera. They drain a densely forested region of heavy rainfall, practically unin-

[1] MOHR, E. C. JUL. (in press): The soils of equatorial regions, with particular reference to the Netherlands East Indies. (A translation by ROBERT L. PENDLETON of: De Bodem der Tropen in het Algemeen en die van Nederlandsch-Indië in het Bijzonder. Six parts, 1933-1938). Edwards Brothers, Ann Arbor, Michigan.

habited except at the gold mines (*cf.* A-3 above). The lower courses of these rivers are through poorly drained, often swampy regions. The very narrow natural levee strips (vega lands) of silt loam and light clay loam, seldom as much as a hundred meters wide, are fair to well drained and reasonably fertile. Crops are produced in two ways: (a) Sugar cane, cacao, some coconuts, and maize are planted on the higher, seldom flooded portions. Bananas did not grow so well on these river bank soils as on those along the Coco river. (b) On the annually flooded lower slopes, toward the river, where deposits of silt mixed with leaves and other forest trash occur annually, after the rainy season the heavy growth of weeds is cut, rolled down into the river, and beans are dibbled into the unstirred soil.

(2) The similar recent sediments deposited by the Coco river have formed very narrow natural levees of brown fine sandy loam and silt loam. These are considered better agricultural soils than those described just above. They produce the subsistence crops of maize, cassava, vegetables and bananas which support the few thousand people who live along this river. This narrow thread of productive soil, through an uninhabited region is, with the exception of the Bluefields locality, the least sparsely inhabited portion of the entire east coast of Nicaragua. Until the Panama and Sigatoka diseases invaded the banana plantations of this region, these soils produced considerable quantities of bananas for the American market.

(3) Since the recent alluvial soils of the lower valleys of the Ulua and Chamelecon rivers in northern Honduras come from mountains (*cf.* A-1 above), composed largely of acidic tuffs, which might be expected to give only poor sediments, it is surprising that the recent alluvia deposited by those rivers are neutral to slightly basic in reaction, well supplied with phosphorus and potassium, and are considered to be among the best banana soils in the world. The mountains in which these rivers rise do not have such heavy rainfall, so that at the start the sediments carried by these rivers are not so thoroughly weathered.

The technic development by the United Fruit Company in this valley for the rejuvenation of the banana lands, thru the controlled sedimentation of diked-in tracts during flood periods of the Ulua river has proved remarkably effective in holding in check the otherwise uncontrollable Panama disease.

(4) By contrast, the Comayagua valley, which is one of the tributary valleys of the Ulua river, has four groups of very diverse and relatively poor soils, namely: (a) Narrow strips of fertile alluvial soils along the river; (b) poor, leached terrace soils, back from the flood plain; (c) poor, black soils on gravelly substrata; and (d) fertile, purplish red clay loam, on some of the hills in the upper valley.

(5) The Pacific slope of Costa Rica has a diversity of lowland soils from older materials: (a) dark heavy soils in the Guanacaste valley; (b) lighter, better drained and well watered soils in the Quepas region, and (c) in the Gulf of Dulce region, the alluvia of the Colorado and Coto rivers excellent for banana production.

(F) *Recent volcanic activity and soils from volcanic products:* In Central America there are several chains of volcanoes, a number of which have been active in recent years, and Izalco has been active practically daily. The most important groups of volcanoes are the following:[2] (1) Along the southwestern or leeward dry coasts of Guatemala, El Salvador, and Nicaragua; and (2) a chain of peaks from Northwestern Costa Rica, running southeast then east to the Caribbean coast. Some features of volcanic activity are of particular importance in soil formation and development; while the positions of the volcanoes in relation to the rest of the land masses are of great importance.

Particularly in a humid tropical region, one of the most important results of explosive volcanic activity is that the thin layer of ash spread over the land from a relatively minor eruption often markedly rejuvenates the senile soil, through the liberation of considerable quantities of several of the important plant nutrients. On the other hand, certain sorts of volcanic ash, if deposited in more than minimal depths over the surface, tend to develop in the deeper portion of the layer a cemented hardpan (talpetate) which only gradually weathers down into soil. Thus the rate of eruption of a volcano is important. In the case of very violent eruptions, such as that of Coseguina, northwestern Nicaragua, in 1833, when within a few hours about 50 cubic kilometers of ash and pumice were scattered over the surrounding land and sea, the soils near the volcano may be buried many meters deep, and are then called fossil soils, so that soil profile development has to start afresh. Such deep deposits of ash may erode spectacularly, as is the case at Lake Ilopango, El Salvador.

The chemical composition of volcanic products varies widely.[1] For the time being, since almost no analyses are at hand of volcanic products from Central America, it will suffice to group these products petrographically into acidic, with up to 65% silica, and basic with as little as 50% silica. When well weathered, the latter group, because of the greater proportion of basic elements, especially iron, and with little or no free quartz, gives heavier, yet physically better, more fertile soils. Air separation of volcanic ash may also be expected to bring about certain differences: more basic minerals falling nearer the crater, the more silicious farther away.

Lava flows, though they have been of relatively slight importance in the later history of the development of Central American volcanoes, impress the casual traveller for, by contrast with the often light colored, thin, widely scattered ash falls, the dark, thick lava flows are conspicuous on mountain slopes.

*Volcanoes and Soils in Guatemala.* — Among the southwestern edge of the older highlands stands a magnificent chain of volcanic peaks. By far the greater part of the ash from their eruptions has been carried by wind and water toward the southwest, where the coastal plain has been built out to a width of between 15 and 40 miles. The soils of the greater portion of this plain are dark colored and relatively coarse textured, while the northwestern portion of this plain, particularly near the foot of the volcanoes, has some unusually excellent, deep silt loams. Bananas are being produced in considerable quantities on this plain, while some *Hevea* rubber is being grown with irrigation. On the intermediate slopes of the mountains

[2] SAPPER, CARLOS (sic) 1925: Los Volcanes de la America Central, pp. 114, Plates 5.

sugar cane is an important crop, while higher up coffee occupies the best soils, with *Cinchona* being planted on some of the higher slopes.

In *El Salvador*, too, the volcanoes stand along the leeward coast, so that even the higher peaks receive but a moderate rainfall. Most of the volcanic ash which has been produced by recent eruptions has been carried out toward the Pacific coast. From a number of volcanoes there have been lava flows. West of the Lempa river numerous small craters of basic rock stand in a region of dark brown, shallow soils. Nearer the capital is the large and very thick deposit of light gray to whitish acidic ash and pumice, so well exposed near Ilopango air port. The coastal plain, toward Herradura, is of practically unweathered gray volcanic gravels and sand, used mostly for pasture. East of the Lempa, at the foot of a different group of volcanoes is the older, more thoroughly weathered reddish brown clay loam, on which much cotton and maize are grown. West of the capital, in the San Andres valley, are considerable bodies of dusty black soil which are underlaid at half a meter or less by tuff (cemented volcanic ash). A more or less similar deposit of dark volcanic ash lies over much of the older, more weathered brown clay loams on the hills to the southwest of this valley. At higher elevations, on the slopes of the volcanoes is a dark brownish black loam, occupied mostly by extensive plantations producing high class coffee. Where the slopes are too exposed and windy for coffee, wheat and maize are grown.

In *Nicaragua* the volcanoes, a number of which have been active recently, also stand much nearer the leeward coast, and likewise in a region of moderate to low rainfall. The soils which have developed from the recent ash falls are brown to dark brown in color and of medium textures. Tuff is common in these soils at a depth of ⅓ meter or less. The "Sierra" southwest of Managua is largely of coarser fragmental materials. On this thousand meter mountain of ejecta has developed a dark grayish brown loam, well suited to coffee. On many of the cones the higher soils are planted to coffee; with maize on the intermediate slopes.

The gently sloping Chinandega coastal plain has excellent dark grayish brown silt loams.

If only the prevailing winds could have been reversed during some of the recent eruptions there would have been a significant rejuvenation of Nicaraguan soils, especially those poor dark shallow heavy loams on the central cordillera and its foothills. (Group A-2 above).

*Costa Rica.* — Even the Guanacaste chain of volcanoes, with a northwest-southeast trend, standing in northwestern Costa Rica has better soil and vegetation characteristics than those of the volcanoes described above. This is because the San Juan river valley extends from their foot to the windward Caribbean coast and permits moisture laden winds to sweep in against the eastern slopes of this range. The soils are friable brown to light brown clay loams. The Poas-Turrialba portion of this chain, standing along the south of the lowlands, and extending east to the shores of the Caribbean, receives heavy rain on its steep, northeastern slopes. The soils of these slopes are light brown friable, light clay loams. The lower slopes of these volcanoes have fertile brown clay loams with an unusually well developed aggregate structure, in spite of only about 200 meters elevation. Within an hour after a heavy shower of 2 inches the clay loam aggregates when gently rubbed between the thumb and forefinger feel almost as firm and sharp as the grains of a sandy loam. *Hevea* rubber does particularly well on this soil.

To the southwest of the Turrialba-Poas chain of volcanoes is the extensive high San Jose Valley, formed by the damming up of vast quantities of volcanic ejecta behind the older Talamanca mountains of metamorphic and sedimentary rocks. In this valley the dark grayish brown to chocolate brown silt loam is 2 to 3 meters deep. This soil has an unusually excellent, friable structure. The climate, too, is ideal for coffee.

At lower elevations farther west, where the rainfall is less, much sugarcane and maize are grown. On the volcanic slopes above the coffee zone much of the forest has been replaced by planted pasture grasses. On the highest slopes are dark brownish black ash loams. Considerable portions of the southern slopes of Irazu are very stony, shallow, steep, and irregular in topography because of numerous small lava flows from parasitic craters. By contrast, the town of Paraíso, not far distant, stands on rounded hills and slopes of deeply weathered red clays, which, because they are slightly out of the path of ash falls from recent eruptions, have not been rejuvenated.

The shallow, stony, steep light brown well-leached clay loams on the Talamanca mountains, to the south of the San Jose valley, show clearly the effects of recent falls of dark ash, for in these mountains it is only in the zone where ash has recently fallen and rejuvenated the soils that coffee is grown.

In the Raventazón valley, not far from Turrialba town, a dark colored rich-looking loam, now mostly in coffee, has proved disappointingly infertile when planted to vegetables. While we must not forget that temperate zone norms and criteria cannot be applied directly to evaluating results of chemical analyses of tropical soils, the quantities of nutrients found in these soils suggest that they are distinctly low in potassium, phosphorus, calcium, and other elements. Moreover, the *p*H of the surface soil is about 5, and of the subsoil about 4.

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H. H. BENNETT: **Soil Conservation in Latin America:** — Effects of soil erosion in every degree of intensity can be found in South America, ranging from ravaged mountain slopes in the Andes and other mountainous regions to incipient dust storms in portions of the range lands of Argentina. In the old agricultural areas of the Andes and on portions of the Mexican Plateau soil erosion and continuous cropping together have ruined or impoverished a very large area of land. A rough estimate (see Table 1) indicates that in several Latin American countries 50 per cent or more of the presently arable land has been severely affected or ruined for further practical cultivation.

On the other hand, in some of the countries including large areas of relatively smooth topography, as Paraguay and the Guianas, damage has been comparatively slight.

According to these preliminary estimates, twelve Latin American countries have suffered

from severe erosion to the extent of about 70 million acres out of some 140 million acres of land now available for cultivation. In some of the twelve countries the estimated amount of land ruined or severely damaged ranges from around 50 to something over 60 per cent of the arable area.

Naturally conditions are worse in the old inhabited sections of the mountainous regions, particularly in the Andean country and portions of the great Plateau of Mexico. Here, there is a relatively heavy concentration of agriculture, with much very steep land in cultivation.

In some of these older farming areas the original forest or brush cover has been pretty largely removed and the land put into cultivation on slopes that range up to 40, 50, 60, 70, and in some places 100 per cent declivity.

sharpened stick, either after burning or directly among the felled growth. Sometimes weeds are pulled out or removed with simple hand implements, but often cultivation is so meager that the field is abandoned temporarily after 2 or 3 years' cropping. In numerous instances yields on such re-used land rapidly decline to unsatisfactory levels as the result of long cropping without replenishment of plant nutrients.

Whatever the cause, the land goes back to brush (*rastrojo*) for variable periods, and again is cleared and planted to corn, beans, etc. This system of land use is common among the small "patch" farmers throughout Latin America, just as it is, also, in some parts of the United States. It is sometimes referred to in Central America as the *milpa* system and in the Andean highlands of northern South America as the *conuquero* system.

*Preliminary rough estimates of presently arable land and areas severely affected by erosion in Latin America:* —

| COUNTRY | AREA | CULTIVATED LAND (INCLUDES ALL LAND IN MAJOR AND MINOR CROPS PLUS FALLOW) | TOTAL LAND NOW AVAILABLE FOR CROPS (INCLUDES CULTIVATED LAND PLUS PLOWABLE PASTURE & MEADOW) | ROUGH ESTIMATE OF AREA RUINED FOR CULTIVATION, NEARLY RUINED, AND SEVERELY AFFECTED | |
|---|---|---|---|---|---|
| | (1000 acres) | (1000 acres) | (1000 acres) | (1000 acres) | Percent arable land |
| *Mexico* | 324,923 | 35,873[1] | 57,714 | 28,857 | 50 |
| *Guatemala* | 27,101 | 2,415 | 3,500 | 1,050 | 30 |
| *Republic of Honduras* | 29,600 | 2,525 | 3,059 | 1,530 | 50 |
| *El Salvador* | 8,500 | 5,000 | 5,000 | 2,000 | 40 |
| *Nicaragua* | 30,000 | 1,000 | 1,500 | 450 | 30 |
| *Costa Rica* | 14,520 | 1,052 | 1,500 | 450 | 30 |
| *Panama* | 21,547 | 370 | 1,000 | 200 | 20 |
| *Colombia* | 291,470 | 5,745 | 11,000 | 5,500 | 50 |
| *Venezuela* | 226,389 | 1,803 | 11,000 | 7,000 | 64 |
| *Ecuador* | 62,170 | 7,982 | 8,000 | 5,000 | 62 |
| *Peru* | 322,198 | 4,077 | 7,000 | 3,000 | 43 |
| *Bolivia* | 268,800 | 10,355 | 15,355 | 6,910 | 45 |
| *Chile* | 183,290 | 14,222 | 16,000 | 8,800 | 55 |
| *Brazil* | 2,102,264 | 79,400 | 100,000 | 20,000 | 20 |
| *Argentina* | 689,799 | 74,000 | 200,000 | 45,000 | 15 |
| *Paraguay* | 111,360 | 7,000 | 7,000 | 350 | 5 |
| *Uruguay* | 46,171 | 3,615 | 6,500 | 965 | 15 |
| *Cuba* | 28,265 | 4,000 | 9,505 | 475 | 5 |
| *Dominican Republic* | 12,370 | 2,500 | 3,500 | 525 | 15 |
| *Guianas* | 114,000 | 300 | 2,500 | 125 | 5 |
| *Haiti* | 6,848 | ——— | 1,712 | 685 | 40 |
| **Totals** | | | 472,345 | 138,872 | 24 |

[1] According to Anuario Estadistico, 1940—"tierra de labor."

On much steep land, where the original growth was heavy forest and the soil was mellow, absorptive of rainfall, and productive, erosion, across the centuries, has disastrously affected a large total area, forcing abandonment of thousands of acres and migration of thousands of farm people.

In addition, one-crop cultivation without rotations that include the soil-building legumes has reduced yields. In some parts of the Andes, and other regions, land that once produced from 15 to 25 bushels of wheat to the acre, without fertilizer, is now either abandoned or is producing only 1, 2, or 3 bushels an acre. In various parts of Latin America, where corn has been grown since time unknown, yields have dropped to as low as 3, 4, 5, or 6 bushels per acre.

A common practice with respect to corn culture that probably originated with the Indians is to chop down the trees and plant with a

The clearing off of the forests followed by extensive steep-slope cultivation, has had a profound effect on the water supply in many regions. In the northern Andes, for example, a good many streams from which ample water formerly was available at all times for irrigation now are completely dried-up early in the dry season. Numerous wells and springs have ceased to flow and some municipalities have experienced costly difficulties in obtaining adequate water for human and industrial uses.

It is not to be understood, however, that these severe effects of improper land use — uncontrolled erosion and over cropping, especially — are a prevailing characteristic of Latin America. There is still a vast acreage of good land in that part of the world, and much untouched virgin soil, as in the Amazon Basin and along the western slopes of Ecuador and Colombia (see Annals of the Association of American Geographers, September, 1925).

As in the United States, the bad conditions are of scattered occurrence. Where topographic and climatic conditions are very similar to those north of Latin America, the effects of erosion and over cropping on land conditions are not markedly different.

*Progress of Soil Conservation.* — Although the world's most outstanding achievement in conservation land use is probably represented by the walled-terrace agriculture of the Peruvian and Bolivian Andes, as practiced by the pre-Incas (see the author's *Soil Conservation,* McGraw Hill, New York), very little progress was made in Latin America generally until within the last two or three years. This is not surprising, since it was only within the past ten years that a comprehensive nation-wide program of soil and water conservation was adopted anywhere in the world.

Recently, however, the soil conservation concept has spread throughout the whole of Latin America and the West Indies area. And with this advance in the thinking of the people with respect to the welfare of man's basic resource, there is little doubt but that the movement will go ahead rapidly. The indications very definitely point in that direction.

Within the year Mexico has established in its Department of Agriculture a Soil Conservation Service, and control and prevention work is getting under way.

In 1941, Venezuela asked the United States to send to that country a group of specialists, to be headed by the writer, "in order to organize the preliminary work and sketch a plan of action for the conservation of the soil and water resources . . ." In response a Soil Conservation Mission to Venezuela sailed for that country early in December, 1941, and subsequently — over a period of six months — carried out reconnaissance investigations of the area north of the Orinoco pertaining to land conditions, including the effects of erosion on soil, water supplies, and agriculture. After ascertaining the general conditions in that part of Venezuela comprising the principal agricultural activities of the nation, considerable conservation work was carried out by the Mission on representative farms in various localities. This work consisted mainly of terracing, contouring, and construction of simple loose-rock check dams in active gullies. When the rains came, the work withstood the impact of erosion to such a degree as to arouse the interest of many farmers. (See "Land Conditions in Venezuela and Their Relation to Agriculture and Human Welfare," prepared by the Soil Conservation Mission for the Ministry of Agriculture, Venezuela.)

Since that time, additional work has been taken up by the Ministry of Agriculture, and it appears that a sound national program of land use and soil protection is being started.

Chile also is carrying on research work along conservation farming lines, and seems likely to go ahead with a nation-wide program. Brazil has conservation work under way now, and Argentina, Colombia, Ecuador, and other countries are planning for research or action programs, or both.

A particularly strong indication of the trend of thinking along the line of soil and water conservation in Latin America is indicated by the fact that thirteen countries (Cuba, Mexico, Chile, Argentina, Venezuela, Uruguay, Paraguay, El Salvador, Costa Rica, Haiti, Brazil, Ecuador, and Peru) sent to the United States this year (1943) twenty-five picked agricultural specialists to work and study with the Soil Conservation Service as student trainees. These young men have all studied the field work of the Service in various parts of the United States — in localities as much like those from which they came as was possible — and have to a considerable degree carried out with their own hands many of the most effective soil conservation practices that are being used.

*Some General Needs of the More Erodible Sections of Latin America.* — Some of the more obvious conservation needs calling for the earliest possible attention in Latin America pertain to nation-wide: (1) Programs of education relating to erosion and water problems — in schools, in the press, on the radio; (2) research programs, by problem areas; (3) land capability surveys like that devised and carried on by the U. S. Soil Conservation Service, supplemented by a conservation needs survey like that conducted by the same organization; (4) inauguration and vigorous prosecution of action programs of work with farmers.

Some of the more outstanding of the immediate needs with respect to physical adjustments in land use are described briefly in the following paragraphs:

*Land Use and Erosion.* — While the kind of soil and the use made of the land have much to do in determining the degree or declivity on which farming operations can be conducted with safety in Latin American countries, cultivation of slopes steeper than about 15 to 20 or perhaps 25 per cent in some instances generally should not be carried on under prevailing practices of continuous clean tillage regardless of soil quality other than that of stoniness. Even these lands of lower declivity will need the protection afforded by such practices, or combination of practices, as contour cultivation, terracing, strip cropping, soil-improving rotations, and surface utilization of crop residues (as a mulch). There is no other way either of preventing impoverishing and destructive erosion or of avoiding soil exhaustion. Here, as in other parts of the world, where slopes of ordinary land are used for the clean-tilled crops, that land ordinarily should be cultivated on the contour if steeper than about 1 to 3 per cent. If the fields are so stony that rainfall is rapidly absorbed, cultivation can, of course, be carried on safely on much steeper gradients. As a matter of fact, many fields so stony that only hand cultivation is practicable are successfully used for corn, yuca, bananas, wheat, potatoes, and other crops on slopes exceeding 50 per cent, and in some instances on slopes up to around 70 to 75 per cent. And, of course, when the land is used for grass and good stands are maintained by reason of sound grazing practices, areas considerably steeper than 35 per cent can be used without initiating serious erosion. If permitted to grow up to forest, naturally or by planting, erosion is readily controlled, when the woodland is not grazed or frequently burned, on slopes of around 100 per cent.

Impoverishing and destructive soil erosion is, in the practical sense, very nearly synonymous in the Andes and similar mountainous country with excessive loss of rainfall by runoff, since

most of the damage is done by water rather than by wind. And, accordingly, the steeper the land, the cleaner it is stripped of protective vegetation, and the straighter the furrows of plows are directed downhill, the greater will be the runoff, and the greater the runoff, the faster the soil will be swept into the rivers. And it is under these conditions that flood hazards are increased and springs and wells and streams run low or dry up.

Other ill consequences that go along with accelerated erosion are loss of water during rainy seasons that should be stored in the land to nourish crops in times of drought, to keep springs and wells filled with water, and to keep the rivers running permanently instead of flooding at one season and carrying no water at other times.

By burning or removing every vestige of vegetation from fields — as corn stalks, the vines of peas, the stubble of wheat, the refuse of new clearings — the soil is laid bare to excessive washing and to depletion of the life-giving vegetable matter — humus — that productive lands require. The sun dries the soil almost to the hardness of stone in the dry season, moisture is dissipated by evaporation, and the beneficial soil forms of life, as earthworms, bacteria, and molds, become relatively inactive. These unfavorable conditions — most of which could be avoided — bring the soil to a state of temporary or seasonal dormancy that is probably harmful to the productive capacity of the land.

The effects of dry climatic conditions of many regions to the south of the United States are such that extra precautions must be taken in using the land either for crops or for grazing. Overgrazing, for example, will strip off the natural vegetation which may be scant because of characteristic dry conditions. And since the rains that do fall in dry areas frequently are equally as intense as those that fall in more humid areas, susceptibility to exhausting erosion may be even greater than where there is more rainfall and accompanying denser cover of protective vegetation.

In the greater part of the mountainous country of northern South America, the better and more accessible lands have long been used for agricultural purposes at one time or another or are still in use. With the dense population occupying these highlands and the long period of agricultural use, it is in no way surprising that much land has been impaired in productivity and that many formerly cultivated areas have been essentially ruined by erosion and more or less continuous use for crops that have gradually sapped the fertility of the soil. The leisurely washing off of the *capa vegetal*, together with moderate to severe gullying, has finally impoverished the greater part of the more favorably situated uplands of some localities, even ruined some rather large areas permanently; washed the soil off, down to bedrock or made the land useless by gullying.

A number of factors account for the frequent low yields and for the rapid failure of crops in dry weather, with consequent need for reclearing second growth and opening new fields in the too few remaining areas of virgin forest, now found principally at the higher altitudes on very steep slopes.

Prevailing declivity of the land, coupled with a dense population and limited opportunity for work off the farm, has induced or forced the cultivation of ever steeper and steeper slopes. Some of these areas — many of them — have slopes of 40, 50, 60, 70, and even in excess of 80 per cent declivity, and some 100 per cent, as determined by actual measurements in various localities throughout the mountainous farm country. Also, in some places livestock graze slopes up to 100 per cent and ocassionally even steeper than this.

When the natural cover of vegetation is removed from such steep lands and the ground is broken or plowed for crops, or when the steep lands are too closely grazed or are too frequently bared of cover by fires, heavy rains tend to sweep the exposed soil down into the streams. This loss of the productive soil, the capa vegetal, often proceeds so slowly that farmers fail to recognize the process of wastage. But when his land becomes so impoverished that crops fail, or when the surface of the ground becomes so compact that most of the rainfall runs off the land, leaving little moisture in the soil for crops, the rastrojo (second, third, etc., growth) to clear, he turns to the nearest available area of forest land and clears that. If there is no more forest land, he is forced to seek off-farm work, move to another locality, or ask for sustenance from relatives and friends or the community.

Another common practice that has contributed to declining yields — in some of the southern regions—is the planting of crops up and down the slope instead of across the slope, on the contour of the land. Such methods cause rainwater to run off the land so fast that it picks up and takes along the soil at a very destructive rate — often all the soil, layer by layer, not taking just the plant nutrients.

It seems strange that many farmers throughout the world have somehow failed to work cooperatively with nature in such manner as to direct their plantings and furrows across the slope, along the contour, so as to intercept water flowing down through the fields and thus store more of it in the soil for crop use later on, and to check erosion. Failure to follow such practice has intensified soil wastage by erosion, across the ages, to such degree that people in many parts of the world have had to seek new lands or new occupations. Many large areas have been so disastrously affected by this wasteful process of erosion that whole civilizations have declined or even disappeared as the result. This has happened to once powerful nations in the old countries of the Near East and along the shores of the Mediterranean.

In some parts of the world, on the other hand, agricultural people have cultivated their land strictly on the contour and have even built walled terraces or benches along the slopes to hold the soil and to conserve rainwater by allowing it to sink into the ground for crop use in times of drought. Remarkable achievements along such lines of conservation of soil and water were carried out by the ancient people of Peru, previously referred to, and even by the aborigines of the Philippines and New Guinea. In Peru, not only were the steep mountain slopes walled up for cultivation but water for irrigation was brought to them by splendidly engineered works.

Another cause contributing to diminished soil productivity and consequent occupation of more and more over-steep land is the general failure to alternate crops in such a way that the land benefits from following those crops which tend to exhaust the soil of its plant nutrients with those crops that improve the soil by adding wholesome constituents — nitrogen and organic matter. Such beneficial alternation or rotation of crops might, for example, be the growing of a legume, such as velvet beans, after or along with a crop of corn or yuca. The legumes add nitrogen to the soil and also needed humus. Corn, the yuca, the potato take nitrogen and other constituents out of the soil and return essentially nothing. Beans and other legumes tend to store in the soil nitrogen taken from the air.

For forests almost any slope can be used except, of course, vertical and nearly vertical areas — where there is little or no grazing and not many fires.

*Need for Additional Information.* — Much additional information is needed on the technical aspects of agriculture as applying to different kinds of land found under conditions of great ranges in slope, altitude, and humidity. Procurement of such information can be speeded through careful experimentation, such as will supply comparative data with respect to the best methods and time of planting and cultivation; varieties; crop rotations; spraying where needed; efficient use of crop residues, livestock manures, and commercial fertilizers; and efficient use of both rainfall and irrigation water. Such experiments in order to be really useful should be carried out on the principal distinct types of land, at various altitudes; and the records should be carefully kept, year by year, until an adequate average of results is obtained to determine local needs. Interpretations of these records should be made for the practical use of practical farmers. Experimental and demonstrational work beyond the capacity of the farmer will not prove very helpful.

*Need for Demonstrations.* — It will not be sufficient merely to gather information on ways to prevent erosion, conserve soil and rainfall, increase yields, and otherwise improve agriculture. Such new information will be of no value unless it is carried out to the farms for practical use.

One way to do this is through ordinary methods of education: Talks to farmers, bulletins, newspaper articles and books describing the results of research. A still better way is to demonstrate the practices through actual work on the land — on practical farms through cooperation with practical farmers.

Experience in the United States has shown that the demonstration method of showing farmers how to use old practices, as well as new ones, has been highly effective in getting under way a national program of soil and water conservation. (See the author's *Soil Conservation*, McGraw Hill Book Co., New York, 1939).

*Need for New Lands.* — Where there is not sufficient land for all the people who want to live on the land, an alternative would be to help them better farms in other localities.

Soil Conservation Service,
U. S. War Food Administration *and*
U. S. Dept. of Agriculture,
Washington, D. C.

A. S. Müller: **Plant Pathology in Latin America:** — It should be recognized at the start that in Latin American countries the importance of plant pathology has been appreciated for many decades just as it has in other parts of the world. Agricultural Ministry reports in these countries show that the farmers and planters, facing the problems of crop failures and losses from diseases, have sought aid from the governments for many years, not being able to cope with these problems themselves, for lack of understanding of the causes as well as for lack of instruction in control measures. Over a long period of years letter after letter has reached the office of federal and local agricultural authorities and innumerable persons have requested interviews for the purpose of obtaining explanations, remedies or the visit of competent persons to help solve these problems. The situation has been handled in different countries, depending chiefly to what extent budget resources permitted the development of plant pathology work and organization.

We find that the early visiting foreign mycologists were usually aided in one way or another during their collecting trips and that they called attention in passing to some of the diseases of cultivated crops. There are a few cases where commissions or individuals were called in from abroad, or sent in to investigate some particular crop failure. Later some countries added to their agricultural staffs men whose work included not only Plant Pathology but practically all the different branches of Botany and Zoology. Some of these scientists became teachers in agricultural and technical schools, where little investigational work was accomplished, since besides teaching various sciences, they were often at the call of the government for carrying out various kinds of agricultural programs or commissions. These men functioned more like encyclopedias than as investigators of special problems. In most cases, they, as well as the earlier mycologgists, sent most of the specimens they collected abroad.

One after another native graduates of local and foreign schools interested in plant diseases and fungi entered the scene. Of those who entered government service, the majority was not employed directly in Plant Pathology work, but their information was made use of as they labored in other agricultural bureaux. In not a few countries, however, Plant Quarantine, Protection or Defense Services came into existence. In some countries laboratories of Plant Pathology were set up, independently, or united with Botany, Entomology or Seed Laboratories of the Ministries of Agriculture. When Agricultural Experiment Stations began to function in various countries, separate from the administrative bureaux of agriculture Plant Pathology units appeared in most of these. In a few cases a united agricultural school and experiment station was created with a single staff, including Plant Pathology as a separate department or joined with Botany or Entomology. It is not of importance in this short discussion to cite specific examples, especially since many changes in organization followed each other in many of the countries. It suffices to say that to-day it is rare to find a country in Latin America entirely without some independently functioning unit of phytopathological work and where some administrative office constitutes the only source of information on Plant Pathology.

For many years phytopathological staffs excluding certain foreign scientists especially contracted, were made up mostly of agricultural school graduates and others who had not received previous training in methods of research or experimental agriculture. Lacking herbaria and with scarcely any library facilities, the determination of the causes of plant diseases by these units was difficult or almost impossible. Remittance of diseased specimens was made, and still is in many cases, to foreign centers for consultation. Lacking sufficient funds for long time experimentation on the control of plant diseases, recommendations were made for combating diseases by some of these groups, without the knowledge that the methods were adaptable to local agricultural conditions. Too often, those responsible for recommending control measures never had the opportunity to leave the Laboratory for the field to determine whether the disease intensity justified control measures in the first place and whether there were profitable increases in production ever obtained by the use of them. At first the literature on Plant Pathology which appeared in the rapidly increasing number of agricultural journals in Latin America reflected clearly the situation just described. Many pages were filled with descriptions of known plant diseases and repetitions of their history in other parts of the world, plus mycological discussions concerning their causes and a few lines giving generalities regarding control. In recommending the use of resistant varieties, no names of any such were given nor any mention of the subject of biological races of fungi.

In the last two decades great advances have been made in Plant Pathology in many parts of Latin Amercia. Countries which used to have one-man inadequately equipped departments or laboratories now maintain well staffed efficient organizations with adequate resources for carrying on all essential work. Members of these staffs have been permitted leaves of absence for specialization in foreign universities and laboratories and many new men have been added, already thoroughly trained in foreign countries for the most exactive kinds of investigational work. Courses in Plant Pathology in many of the agricultural schools in Latin America have so completely captured the interest of the students, that large numbers have looked for work in this field after graduation and have selected this subject for specialization on getting the opportunity for advanced study abroad.

The foundation of our knowledge of the fungi which cause plant diseases in Latin America having been laid by two great mycologists, C. SPEGAZZINI in Argentina and A. PUTTEMANS in Brazil, who assembled invaluable herbaria early in the century. Students of theirs and others, in those and other countries, began organizing more complete information on the disease situation through systematic plant disease surveys. Such surveys are available today for Argentina, Brazil, Colombia, Cuba, Mexico, Peru, Uruguay and Venezuela, and are nearly ready in a number of other countries. The Plant Quarantine, Protection or Defense Services, as they are variously called, operating in many of the countries today, are usually responsible for this kind of work. They are constantly recording new data on diseases. In Argentina and Brazil these services control the commerce of fungicides, maintaining laboratories for the analysis, preparation and testing of them, and in the former country, fungicide factories. Also in Argentina, this service has supervised the production of disease free potato seed, and in Brazil has supervised the exportation of citrus fruit to prevent losses from rots in shipment. Such a large amount of legislation concerning plant protection has been coming into existence in many countries that it was proposed by Argentina at the Second Interamerican Conference of Agriculture that a central organ or office be established for gathering all the information on the subject and preparing it for general distribution. This proposal, amplified to include coöperation in all phases of Plant Pathology and Entomology, became resolution No. 32 of this conference and it included a recommendation for the elaboration of a glossary of technical terms, corresponding in English, Portuguese and Spanish, for the more perfect understanding of all concerned. By its own initiative the Instituto Biológico de São Paulo is establishing a directory of Plant Pathologists in Latin America. That this is opportune is indicated by the fact that at the first Congress of Phytopathologists of Brazil held in Rio de Janeiro in 1936, there were more than fifty accredited delegates. There is today probably an equal number or more Plant Pathologists in Argentina than in Brazil.

In Argentina where cereal crops are greatly damaged by rusts and smuts, much has been done towards obtaining resistant varieties, and in Brazil, Uruguay and Venezuela efforts are also being made to substitute for the susceptible varieties. In Campos, Brazil, Tucumán, Argentina and in Cuba varietal resistance of sugar cane has been under study for many years. Brazil has tackled serious *Citrus* disease problems and Argentina potato disease problems of a virus nature and made great progress. In Central America the way in which the control of the *Cercospora* blight of banana has been worked out in several countries constitutes a milestone in the history of plant disease control. Although cacao is grown in no more unhealthy regions than banana in various countries, to date no significant control work has been accomplished in areas severely affected by two of its most destructive diseases, the witches broom and the *Monilia* rot. In spite of the importance given in literature on coffee diseases to the *Omphalia* leaf spot and the actual use of sprays in some regions, reliable data obtained from controlled experiments is still to be had to prove just how profitable spraying of coffee may be. Little pathology work appears to have been done on the two very important subsistence crops in Latin America, beans and corn, towards developing disease resistant varieties. The losses from *Diplodia* ear rot of corn are high in parts of Brazil, Guatemala and Venezuela and there are years of severe losses from anthracnose and rust of beans in the same countries, with no special attention being given these problems. Lately there has been a revival of interest in *Hevea* disease problems in several countries and in Guatemala *Cinchona* diseases are beginning to be studied. It is obvious that the scope of Plant Pathology in Latin America is exceedingly great and that only a few of the problems are being touched on in this paper.

No more efficient organization of Phytopathology exists anywhere than the Dirección de Sanidad Vegetal in Buenos Aires, headed by Dr. J. B. MARCHIONATTO and no finer research de-

partment than that of the Instituto Biológico of São Paulo or that of the Instituto Agronómico, Campinas, Brazil, the former under the direction of Dr. A. A. BITANCOURT. The departments of Plant Pathology of the many agricultural schools today are making contributions of value, in addition to teaching, in a number of countries, including Argentina, Brazil, Colombia, Costa Rica, Guatemala and Venezuela, to mention only a few of them. The names of these department heads and others constantly come to the attention of their colleagues in other countries and the public through their many contributions in current agricultural journals and are too many to cite here. With the establishment of efficiently operating Plant Pathology departments in new experiment stations about to be started in several countries, such as El Salvador, Ecuador, Nicaragua and Peru, under joint management by those countries and the United States, we can look forward to the undertaking of many problems hitherto untouched for lack of resources. It is encouraging also to look forward to the operation of a very strong department of Plant Pathology in the new Interamerican Institute of Agricultural Sciences now under construction at Turrialba, Costa Rica.

ESCUELA NACIONAL DE AGRICULTURA,
VILLA NUEVA,
GUATEMALA.

ARNO VIEHOEVER: **Food Aspects in Latin America**: — Ours—even in this war—is still comparatively the "Land of Plenty." Yet 50 millions, or over one-third of our families, consume a poor, inadequate diet. One man in seven was found unfit for military service, due—directly or indirectly — to nutritional want.[1, 2]

No wonder this country is being aroused to abolish this handicap of hidden hunger. The strategy of hunger combat is not limited to a domestic scale. It engulfs the United Nations and indeed the entire globe where nutrition, as well as social order, is undergoing a dramatic revolution.

Essentially all of Latin America has joined in this international campaign for better nutrition and actively participated in the Hot Springs Food Conference of 44 countries. Not overcrowded like India, nor war-ridden like Greece or China, the masses in Latin America generally — nevertheless — have suffered greatly, and still suffer much from ill- and under-nourishment.

*Cause and Effect.* — At least 50 millions of the 120 millions in Latin America, according to WILSON's recent statement[3] "are sick — sick of everything from sprue to leprosy. Beriberi, pellagra, and numerous other nutritional diseases, such as scurvy and ophthalmia, are evidence of submarginal diets. Scores of other diseases represent symptom complexes resulting from chronically insufficient diets. So, very probably, are leprosy, amoebic infections, tropical ulcers and tuberculosis. With few exceptions, they are most virulent where poverty is most intense and where diet is least adequate." Evidence is accumulating that even malarial attacks are much more severe and more often fatal in undernourished people.

Published statistics of average life expectancy and of the average yearly death rate show, in comparison with certain Latin American countries, and especially their larger cities, that elsewhere residents can attain up to double the lifespan; and larger cities suffer only half the mortality rate.

Evidence is at hand that agricultural practices were as a rule and to some extent still are at a primitive level through lack of tools, both hand and machine, lack of superior strains of seeds, lack of suitable crops and crop protection, lack of storage and processing facilities, and lack of organization, management and financial resources.

Faulty food habits and the excessive production of cash or industrial crops in preference to truck or food crops have added their share to the causes of partial starvation. Ignorance and superstition have held back the wholehearted adoption of certain proven foods. In certain sections of Northern Brazil, citrus fruits and even Brazil nuts are believed to destroy virility; and people, refusing the cure of eating those fruits, have died of vitamin deficiency rather than risk the imagined forfeit of their manhood. In parts of Cuba, peanuts are considered indigestible as human food. In Haiti eggplants were refused as inedible by starving natives. More examples could be mentioned of stubborn, unwarranted prejudice, misinformation or indifference.

*Collaboration and Coordination.* — With the application of modern agricultural procedure and creative biology, *e.g.*, through farm planning, soil and plant analyses, crop selection, rotation, pest protection, fertilization, inoculation, and irrigation (where necessary), improved handling and storage, livestock selection and breeding (insemination, etc.), cooperative farming and financing, progress is on the way.

Latin America has much to offer in this Inter-American enterprise for food production and fraternal labor for the health of this hemisphere.

What started 20 years ago in Santiago, Chile, as a result of a conference of American states led to such significant reforms as:

1. Creation of public health departments for their various governments.
2. The stabilization of quarantine laws.
3. The enactment and enforcement of pure food and drug laws.
4. A standard Pan-American sanitary code, etc.

Other Inter-American conferences since then have recommended increased public education in nutrition and studies of national food problems, the support of public school gardens and school lunches,[4] the establishment of "restaurantes populares" (serving balanced meals at low cost), concerted action in the control of malaria and other hazards menacing Pan-American health.

After the *Third International Conference on Nutrition,* under the auspices of the League of Nations at Buenos Aires in 1939, the National Institute of Nutrition there resolved to become a Latin American University center for the study of nutrition.[5] Brazil has two Institutes of Nutrition: one connected with the University of Rio, the other with that of São Paulo; and a new government Institute of Food Technology. Uruguay, Peru, Venezuela, Mexico, Cuba, Chile and other Latin American countries (in all thirteen or more) have institutions dealing, at least in part, with child and adult nutrition.[4]

The emergencies created by the fury of the second World War have accelerated the formation of new cooperative working units or enlarged the scope of existing ones. Thus we find cooperative agreements signed between the ma-

jority of Latin American countries with the United States of America for joint food production, health and sanitation improvement, industrial development of resources, rehabilitation and education. This work is guided in part by Mr. NELSON A. ROCKEFELLER, Coordinator of Inter-American Affairs, representing this country.

Experts in the various fields of Agriculture, Medicine, Nutrition, Biology and Engineering from the United States of America are engaged in strenuous co-labor in the pampas (plains) and mountains, the jungles and the cities of Latin America with native experts or students for the improvement of conditions.

Thus, the Office of the Coordinator of Inter-American Affairs has already established the new Inter-American Institute of Agricultural Sciences at Turrialba, Costa Rica. With various other war agencies, as well as our Departments of Agriculture and State, it actively participates in other collaborative plans to solve general and local problems of agriculture through many of the Experiment Stations set up in various Pan-American countries; or distributing quality seeds, tools and loans to individual deserving farmers and farmer groups. We encourage, support or undertake projects for irrigation, drainage and suitable water supply, the breeding of poultry, dairy and beef cattle and other livestock, the collection, preservation and processing of fish and introduction and selection of food producing plants in the aim to provide and maintain adequate sources of good food and water.

In the creation of health centers and hospitals this office and particularly the Division of Health and Sanitation lend a helping hand to care for the sick, to study the disease in order to control, cure or prevent it.

The joint maintenance of the Pan-American Sanitary Bureau by member nations of the Pan-American Union and the activities of the American International Institute for the Protection of Childhood are other testimonials for the cooperative spirit prevailing.

*Outlook.*—In the many Latin American territories favored by potentially fertile fields, human engineering should be able to keep them productive and to establish and maintain societies of well, instead of sick, people. Many extensive areas in the Latin American countries may come to be considered among the great food producing regions, satisfying the essential dietary needs for home consumption; especially if suitable balanced rotation is practised and efficient manuring or soil conservation. Increased knowledge of the exact needs for tropical and sub-tropical crops will provide the basis for the production of improved foods and consequently provide better nutrition.

Increased emphasis in child and adult education on the relative need of the various food elements (rather than exclusive selection by taste, looks, custom and habits of food preparation) must be the logical weapon to forge a new attitude and understanding in the mind of the masses—young and old.

Through analyses of an Inter-American or International Specialized Food Research Unit and of the Nutrition Institutes, which we hope to see function in every nation to the South, we shall learn of the limitations of every food and food preparation from the standpoint of efficient and sufficient nutrition. Helpful surveys, such as indicated here and others, have already been made in Latin America.[6, 7, 8, 9, 10, 11, 33, 34]

Through the establishment of health centers, the activity of nationals serving as physicians, nutritionists, health nurses, school nurses, etc., a check on the fact and degree of adequate nutrition of the population will be made possible. The organization of training units for native dietitians, food technologists, food analysts and efficient home economists will provide the workers, and the teaching staff for the education of the food managers or processors and housekeepers on whom so much depends in the intelligent and economical selection, preparation and combination of the food needs.

What has been possible especially in the Dutch East Indies in the utilization of greens as food sources for vitamins and minerals should also be possible in the many places of Latin America where "even fence posts sprout."

Among the quick growing vegetables and greens recommended for the tropical and subtropical regions (and not mentioned elsewhere), the following at least deserve increased attention: alfalfa, beets, broccoli, cabbage, carrots, cow- and Chinese pea, cucumber, eggplant, Jerusalem artichoke, mustard greens, okra, onion, common parsley, Peruvian parsley (*Petroselinum crispum*), peas, pumpkins, plantains, radish, spinach substitutes—Bengal spinach (*Basella alba* and *cordifolia*), "Tampala" or Ceylon spinach (*Amarantus gangeticus* L.), New Zealand spinach (*Tetragonica expansa*), Philippine spinach (*Talinum triangulare*)—sad (*Amarantus oleraceus*), squash, turnip greens and roots, potato, sweet potato and yam, and various types of beans, including the common "yard long," the non-toxic varieties of Lima (all *Phaseolus* species),[12] and the winged or *segudilla* bean (*Psophocarpus tetragonolobus*).[13, 14, 15]

Thus the extended growing of vegetables and fruit, even on the small scale of home and school needs, will add its share to supply the protective foods of vitamins, minerals, trace elements and certain proteins. This is especially true when we choose the best strains of quick growing crops, *e.g.*, tomatoes and peppers, or soybean sprouts, all potentially rich sources of vitamin C.

The supplementation of essentially carbohydrate crops, mandioca (cassava), common bean and corn, home-husked, brown or polished rice, and other preferably "under-milled" cereals, such as wheat, oats and barley, with protein foods from both vegetable and animal origin, will be a move in the right direction.

The replacement of toxic strains such as found in cassava (by non-toxic varieties) will greatly add to the food and safety value inasmuch as their glucoside—yielding the toxic hydrocyanic acid—must be removed; this results in unavoidable losses of protein, riboflavin and minerals.

Similarly, dasheen or taro (*Colocasia*), and related aroid tuber varieties may contain a toxic substance "sapotoxin," which must be removed for safe consumption with consequent food losses, unless non-toxic strains are grown.[16, 17]

Those fats, having a greater dietetic value, should be given preference in order to prevent deficiencies in the natural fat-soluble vitamins and certain unsaturated fatty acids, thus averting ex-

cessive dryness of the skin and other skin abnormalities.

Fat fish may likely also, in Latin America, furnish one of the cheapest foods for body building and protective purposes, containing probably the vitamins A and D, and the minerals calcium, phosphorus and iodine (special processing softens the bones of fish to make them edible, as well, for increased mineral utilization.)

Fats of vegetable origin, evidently play essentially the same part in the metabolism as animal fats. Thus, enriched margarine from both animal and vegetable sources is recommended now as a cheap substitute for butter. The fat of the corozo palm nut, containing pro-vitamin A, according to COWGILL,[9] is a superior food compared to processed vitamin-free cottonseed oil, now used instead by Latin American natives. The avocado and olive are fruits rich in oil. Both contain vitamins A and B complex, the avocado being considered a good source for A, $B_1$, $B_2$ and C.

The supplementary addition of soybean especially, or peanut and cottonseed, to cereals, etc., will add high value proteins[18] and needed amino acids to the meat- and protein-deficient diet at a very low price level, and yield valuable oils as by-products. Parboiled and thus vitamin-richer rice, the millets, sesame seed (rich in calcium), and quinua (or "Inka rice") are promising additions of proven food value. Other local, valuable foods will likely be discovered on critical search.

The addition of food yeast[19] or other concentrated food supplements, *e.g.* heated soy proteins, casein, cereal (corn or wheat) germs, rich in or enriched with vitamins, and the increased use of sprouted beans will furnish new economic sources of proteins and vitamins, as will increased supplies of fish, shrimp, poultry, eggs and dairy products (milk, butter and cheese) especially when adequately dried and stabilized. Great saving of milk costs may be expected from the distribution of whole milk powder for reconstitution in the home.

The increased use of animal blood as a supplementary food of high protein content will come, we trust, with the increased meat supply and the perfection and cheapening of the dehydration methods, and its incorporation in stable products. Blood sausage is a popular food with some people in this country and in Europe. The Eskimos consume the blood of seals, and reindeer; the Chinese that of fowls; African tribes that of the newly-slain rhinoceros. In tropical Asia, I found blood, especially of the monkey, highly treasured by the natives. Dried human blood plasma has become well-known as a great benefit in replacing the blood losses of the wounded soldiers.

That animal protein may, however, be replaced by vegetable protein concentrates, provided the vitamin ration and mineral needs are adjusted, has already been demonstrated experimentally for many domestic animals and should apply to man as well.[20]

Similarly, through the medium of acceptable fresh and dehydrated vegetable soup mixtures, new opportunities are opened for the efficient, economic, nutritious sustenance of the masses.

Increased fruit consumption,[21] *e.g.* of such as the anonas, the avocado, banana, breadfruit, citrus fruits, grape, guava, jujube, loquat, mango, melon, papaya, pineapple, mangosteen, etc., in the warmer, and of apples in the moderate zones, will add greatly to provide a balanced diet; especially when collected from strains high in content of essential food ingredients (vitamins, minerals, amino acids) and digestive enzymes, the latter generally disregarded in diet evaluations.[22] Dates and figs, grown where suitable, would also be desirable additions.

Banana is particularly important inasmuch as it can be grown almost anywhere in the tropics and sub-tropics, and is the most readily digested basic food known. Its over-all nutrient value is biologically proven in special human feeding tests, and by the sustained growth and reproduction of fruitflies (*Drosophila*). Guppies are being well maintained in my experiments for ten months now on banana alone, even though the drum-dried and air-stored powder thus far has failed to provide full growth and reproduction. In addition to the fresh fruit, we need to develop its fullest use as a supplementary dried and stabilized product comparable to raisins produced from grapes. Banana juice presents another possible food product.

Banana is rich in certain nutrients and vitamins.[23] The latter may vary much in amount. (Malayan varieties varied from 30 to 700 International units of pro-vitamin A). When we know all the factors which influence the content in desirable food constituents of this and other fruits, we can then aim for the highest yielding strains, economically possible.

Guava, especially in the rind and outer flesh of the ripe fruit, has a high vitamin C content, retained upon drying at 130° F. and subsequent powdering.[24]

Among the nuts, the Brazil nut, cashew, coconut and macadamia[25] have a high nutritive value, adding to the protein of the diet and furnishing substantial sources of fat.

Both coconut meat and macadamia kernels are dehydrated; the first grated or shredded, the second cooked, roasted and salted. The cultivation of the edible starchy chestnut and the oily walnut where suitable, would be a desirable new development.

With all these foods to choose from, we should be able to overcome any serious deficiencies in nutrition; such as the marked insufficiencies of good protein, of the vitamins $B_1$, $B_2$, niacin, C, and of the mineral calcium now observed in this country.[26] Similarly the very same deficiencies, including also vitamin D, and fat (or others) — observed in very limited but quantitative surveys in Latin America — should be removed or prevented.[9]

The deficiency of calcium, interestingly, is solved by Mayan Indians in Toledo (British Honduras), eating regularly calcareous earth[9], by natives in the Far East, eating the ash of bones (approximately 3 grams daily).[27]

As is well known, England adds calcium in the form of carbonate to its bread. The choice of the best form of calcium to use is still under consideration in this country.

*Conclusions.* — Indeed the outlook for a solid foundation of nutrition in Latin America is to be found in the adoption by the masses of at least the minimum requirements of food essentials and consumption of foods containing them, diversified, enriched or fortified — if necessary.

Such a conclusion is but an extension of the firm belief accepted now in this country and abroad that there are absolute basic food needs

for well-being and well-keeping, filled by "rock bottom" diets without luxuries (such as candy and drink).[28, 29, 30, 31, 32, 35]

The greatest need now is the sensible selection and combination of foods. Thus the knowledge of adequate nutrition is placed into general practice.

From personal experiences in this and many other countries, including the Orient, I know that good food for sustenance and growth can be had at a much lower price level than generally believed by both the poor and the well-to-do. A good balanced palatable diet need emphatically not be an expensive one. Every new contribution towards adequate nutrition opens also new opportunities for more economical diet combinations. Equally the synthesis of vitamins and the industrial use of proteins or their by-products have enormously reduced their cost for food supplementation.

If the *uptake* by the body's absorptive tissues of these essential nutrients is provided: that is a day-in, day-out perfect, palatable and digestible diet in sufficient amounts, likely irrespective of the cources of food — vegetable or animal —, the common benefit anywhere will be a better health, a prolonged life, alertness, straight posture, increased stature, sound teeth, firm muscles, red blood — in all, an increased buoyant fitness or vitality.

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ARTHUR BEVAN: **Forestry in Latin America and Its Future:** — Latin America, including all of Central and South America south of the Río Grande as well as the Caribbean Islands, has a total land area of 8,332,662 square miles or approximately two and three-fourths times the size of the Continental United States. Total population, according to the latest available figures, mainly based on 1940 Census, is 132,-304,000, or only about 600,000 more persons than the 1940 population of the United States.

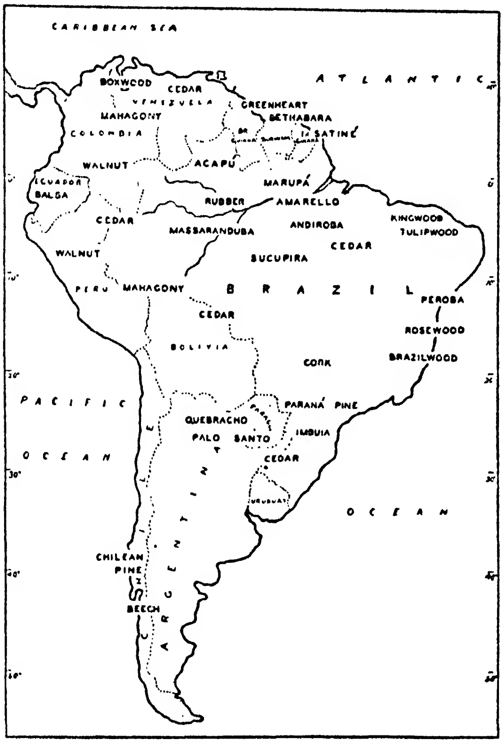
According to the best information obtainable 40 percent, or 3,325,000 square miles, of this entire area is forested, as shown in the accompanying table. This is an area greater by 10 percent than the total land area of the United States. Brazil alone has a larger forest area than the 1,000,000 square miles of forest land in the United States, of which only 75 percent is classified as commercial forest land.

About 80 percent of Latin America lies between the Tropic of Cancer and the Tropic of Capricorn and thus is classed as tropical, and of the remainder a large proportion should be classified as sub-tropical. Therefore, the forestry problems of Latin America largely resolve themselves into the management and utilization of tropical forests, a subject concerning which very little is known and on which a very small start has been made.

With the exception of Argentina, Chile, and Uruguay, which have relatively small areas of forest, and El Salvador and some of the Caribbean Islands which have been largely denuded, all of these countries contain large forests of which much has never been explored and the composition is unknown.

It is hard to realize that, although these countries were discovered and many of them settled long before the United States, it is possible even today to find mature stands of unexplored forest within relatively short distances from their capital cities. It must be remembered that the tendency of populations in Latin America is not to spread out but usually to concentrate in definite regions. Except in such inhabited sections, the only means of transportation and communication are the rivers and only the larger of these in the lowlands can be used for transportation.

Lands adjoining centers of population, or which can be reached by fairly good roads, by railroads, or by water are almost invariably denuded of forest cover. Forest products such as lumber, poles, fence posts, fire wood, and




PRINCIPAL COMMERCIAL TIMBERS AND THEIR GENERAL LOCATION IN SOUTH AMERICA (*From* RECORD'S "Timbers of the New World," New Haven, Conn., 1943).

GENERALIZED FOREST MAP OF CENTRAL AND SOUTH AMERICA (Timber Stands).

charcoal in these centers are expensive, despite the fact that beyond the confines of these inhabited areas lie untouched and often unknown forest resources. A good illustration of this is the recent discovery of a pure white oak forest (*Quercus copeyensis*) in the mountains overlooking the valley in which the ancient capital of Costa Rica, Cartago, was built centuries ago. This mountain area is now being opened up by the Inter-American Highway, and ultimately a twenty-mile drive will take one deep into this beautiful stand of oak trees, many of which are 7 and 8 feet in diameter, with trunks 80 feet to the first limb. There are hundreds of thousands of acres of this forest, never penetrated or utilized up to the present time. Brazil also, despite her large forest resources, has for years planted eucalyptus for railroad ties and fuel for her railroads. Caracas, Bogotá, Quito, La Paz, in fact nearly all the capital cities of these countries, because of lack of transportation facilities, are without adequate supplies of forest products. This has awakened local interest in reforestation and planting programs.

Many of these countries have forest laws, some of which are much more restrictive regarding cutting than those in the United States; but only Mexico, Brazil, and Chile have any semblance of a Forest Service to administer them. In other cases the forests are administered by the Department or Minister of Agriculture, but in no case, so far as is known, is a trained forester in charge, or are nationals trained in forestry for such positions. The result is that in general there is little or no administration or management of these forests and forest lands. The only exception are the British Colonies, which have had a Forest Service for years under a Conservator of Forests. Much excellent work has been done there, but as funds for research have been almost negligible, trial and error has been through force of necessity the method employed. Fortunately, careful records have been kept and thus a great deal can be gleaned from the work of these British foresters.

In 1939 the U. S. Forest Service established the Tropical Forest Experiment Station with headquarters in Puerto Rico. The main objective of this research station was to act as a center of forest research and to assist forestry activities in all the countries of tropical America. Some progress has been made on this ambitious program, but the small funds available to the Station have handicapped it seriously. An increase in personnel is essential to place the Station in a position to render the services for which it was primarily established and to carry on the basic research program ultimately essential to the management of these tropical forests.

One of the most immediate needs for both utilization and management is a survey to determine the extent and composition of these forests. It is obvious that no overall research program can be carried out until we know their extent, their composition, and their uses. Such a determination must be made before it is possible to determine the products to be sought or the objectives of management.

A start was made this year (1943) through a project sponsored by the Coordinator of Inter-American Affairs and carried out by the U. S. Forest Service. Titled the Latin American Forest Resources Project, it placed parties in the field in Costa Rica and Ecuador to make a study of the forest resources of these countries and the uses to which they were best adapted. Discontinuance of the project in June 1943 left much of this essential job yet to be done.

In addition to a survey of the extent of the

forest, determination should be made of the characteristics of all species which occur in commercial quantities, as a means of establishing their proper utilization. The hundreds of species which fall within this category will necessitate a tremendous job of testing these woods, but it is a job that will have to be done. Unless the wasteful utilization of the tropical forest by the prevalent high-grading of a few high-value species, such as mahogany, is brought to an end, a very large percentage of the last great stand of hardwoods will be destroyed, contributing relatively little or nothing to the economy of the countries in which they lie.

| Country | Population 1940 | Total area sq. miles | Forest area sq. miles | Percent forested |
|---|---|---|---|---|
| Argentina | 13,518,000 | 1,078,278 | 193,750 | 18 |
| Bolivia | 3,426,000 | 537,792 | 200,000 | 37 |
| Brazil | 41,357,000 | 3,275,510 | 1,562,500 | 48 |
| Chile | 5,001,000 | 296,717 | 60,000 | 20 |
| Colombia | 9,523,000 | 448,794 | 237,200 | 53 |
| Costa Rica | 656,000 | 23,000 | 14,000 | 61 |
| Cuba | 4,200,000 | 44,164 | 7,812 | 18 |
| Dominican Republic | 1,617,000 | 19,332 | 13,275 | 69 |
| Ecuador | 3,200,000 | 275,936 | 91,406 | 33 |
| Guatemala | 3,284,000 | 45,452 | 18,750 | 41 |
| Haiti | 3,000,000 | 10,204 | 5,000 | 49 |
| Honduras | 1,105,000 | 44,275 | 37,890 | 86 |
| Mexico | 19,473,000 | 763,944 | 156,250 | 20 |
| Nicaragua | 1,380,000 | 60,000 | 45,000 | 75 |
| Panama, inc. Canal Zone | 688,000 | 34,216 | 20,000 | 58 |
| Paraguay | 1,015,000 | 174,854 | 43,000 | 25 |
| Peru | 7,023,000 | 532,000 | 270,000 | 51 |
| Salvador | 1,745,000 | 13,176 | 1,400 | 11 |
| Uruguay | 2,147,000 | 72,153 | 2,200 | 3 |
| Venezuela | 3,493,000 | 352,170 | 188,600 | 54 |
| Br., Fr., & Dutch Guiana | 525,000 | 208,812 | 168,000 | 80 |
| Br. Honduras | 60,000 | 8,598 | 6,020 | 70 |
| Fr. West Indies | 551,000 | 968 | 311 | 32 |
| Trinidad | 485,000 | 1,862 | 930 | 50 |
| Jamaica | 1,235,000 | 4,780 | 1,195 | 25 |
| Balance Greater & Lesser Antillies | 654,000 | 2,117 | 347 | 16 |
| Puerto Rico & Virgin Islands | 1,894,000 | 3,558 | 355 | 10 |
| Total | 132,255,000 | 8,332,662 | 3,345,191 | 40 |

In the areas of heavy population, consideration should be given to comprehensive forestry programs to restore forest growth on sub-marginal denuded lands. Such programs will not only provide the essential fire wood, charcoal, posts, and poles for these people but under management will check erosion and restore these lands to a useful economy. Much remains to be done in determining the species which should be planted for such purposes. Quick-growing native species, which coppice readily and which yield these needed products in quantity, are much more desirable than the slower-growing, high-value timber trees. In Puerto Rico a coppice of Pomarosa (*Jambos jambos*) close to transportation has produced fire wood, charcoal, posts and poles at the rate of $50 per acre per annum at very little cost to the owner except for cutting.

One of the greatest needs for the future of forestry in Tropical America is a medium of training men in tropical forestry. All so-called tropical foresters today are men with temperate zone training in forestry who have learned the hard way, having to be first convinced of the futility of trying to apply temperate zone techniques and methods to tropical forests. Basic training can be obtained at any accredited forest school, but the latter stages should include actual training in the tropics. So far, no such course is available and no provision has been made for the training of men, particularly the citizens of the countries in which these tropical forests occur. Until such provision is made, progress in tropical forestry in the Western Hemisphere will continue to be very slow, and high-grading of these forests will continue.

With tremendous areas of forest in Latin America untouched, the future of forestry and maintenance of this valuable resource will depend on:

1. The establishment of Forest Services or Bureaus to enforce forest laws and develop forest practices and management in each of the countries.
2. The expansion and development of research in tropical forestry, particularly at the start to determine the extent and composition of the stands and determination of the physical and mechanical properties of the species occurring in commercial quantities.
3. The establishment of a school or schools for training tropical foresters and particularly citizens of the countries in which these forest resources are found.

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ALBERT F. HILL: **Ethnobotany in Latin America:** — In Latin America, as in North America, comparatively little outstanding ethnobotanical work has been carried on. Although considerable data is to be found in articles and books on history, geography, travel and general works in economic botany and anthropology, this data is apt to be superficial and inadequate.

JONES (42) has pointed out that ethnobotany is not a mere listing of useful species but rather "the study of [all] the interrelations of primitive man and plants." It occupies a position midway between plant science and anthropology and should draw on both these sciences for its approach, methods and data. The latter should be presented in such a manner as to be valuable to both botanists and ethnologists. In the past anthropological writers have often had insufficient botanical knowledge and consequently have

failed either to use or to interpret properly the botanical data. Similarly the botanist has often lacked an understanding of the problems and aims of the anthropologist, and has rarely attempted to analyze the data he presents.

There are many sources available for the ethnobotanist with the necessary dual background. First-hand observation of the actual uses of plants by primitive peoples is still of first importance. The accurate interpretation of the literature in the fields of botany, ethnology, archeology, linguistics, agriculture, folk-lore, history, exploration, medicine and pharmacy offers great possibilities. The identification of vegetal remains gives valuable information in regard to ancient civilizations. All these sources of ethnobotanical information are abundantly present in Latin America, and the majority of works referred to in the present discussion have followed one or another of these lines of investigation.

SCHULTES (90) has adequately summed up the objects and needs of modern ethnobotany with especial reference to the problems of Latin America.

The literature reviewed in the following pages by no means constitutes a complete bibliography of Latin American ethnobotany. Rather it represents the more important works (published for the most part during the last twenty years) which have come to the reviewer's attention.

*Ethnobotany in Mexico.* — Considerable progress has been made in Mexico in recording the native uses of plants by direct observations. JOHNSON has investigated the Mazatec Indians and has published some general ethnobotanical observations (40), and a more detailed discussion of divination and witchcraft (39) as practised by these Indians, with reference to the plants and plant products utilized. LOPEZ CHIÑAS (45) has discussed the utilization of various plants by the Zapotec Indians. SCHULTES has published a series of papers (85, 86, 91, 92) dealing with the uses of plants by the Indians of Oaxaca, and has ready for publication a comprehensive work on the economic botany of Oaxaca (89).

Individual plants or plant products have also been investigated. SCHULTES, in a series of papers (79, 80, 81, 82, 84), has discussed the narcotic *peyote,* treating of its characteristics, its use in religious ceremonies, its therapeutic value and species confused with it. Perhaps the greatest value of this work is the clearing up of the confusion which has existed in the literature in regard to the identity of peyote. SAFFORD in 1915 (74, 75) erroneously identified peyote as teonanacatl, a misconception which has been followed by many other writers. SCHULTES leaves no doubt that the cactus *Lophophora williamsii* is the correct source of this ancient narcotic. REKO (66) has also published a lengthy account of peyote and its uses.

Another narcotic, *ololiuque* or *piule,* has been studied. SANTESSON (77, 78) investigated the use and effects of the drug and its chemical nature. SCHULTES (88) has published an exhaustive study of ololiuque, discussing its use among the Aztecs, and modern Indians as well, its characteristics and its botanical history. Figured correctly as a convolvulaceous plant by HERNANDEZ and SAHAGUN it was identified by URBINA in 1897 as *Rivea corymbosa.* SAFFORD, however, in 1915, (75, 76) erroneously identified it as *Datura meteloides* and this incorrect name has had wide acceptance. Recent collections of the plant in Oaxaca show that the correct determination is *Rivea corymbosa,* as pointed out.

VON HAGEN has investigated Mexican paper-making plants. A brief account of the species involved (112) was followed by a beautifully executed volume (113) dealing with all phases of the paper-making art in both ancient and modern Mexico and including samples of the different kinds of paper made. The art of paper-making as practised by the Aztecs and Mayas is described in detail, as is the experimental work which established the identity of *amatl* as a moraceous plant rather than as maguey (a belief long current). A study of present-day paper-plants shows that some dozen species of the *Moraceae,* chiefly *Ficus,* are involved. In all probability the principal sources of paper in pre-hispanic time, as at present, were *Ficus cotinifolia* and *Ficus padifolia.*

REKO (65) has discussed the history of cotton in Mexico, emphasizing the part it played in the culture of the Aztecs and Mayas. ALBA (1) has presented a detailed account of all phases of the maguey and pulque industry; while MARTIN DEL CAMPO (52) has pointed out the important role that pulque played in pre-Cortesian Mexico.

Several workers have investigated the medicinal uses of plants. MARTINEZ (54) has discussed the present state of knowledge of medical botany in Mexico, pointing out how much inaccurate data has been accumulated owing to mistaken identifications, misapplication of common names, etc., and citing the recent work in this field. The same author's work on the medicinal plants of Mexico (53), while not primarily ethnobotanical, contains much information as to the native uses and history of drug plants. RIVERA MORALES (68) has made an extensive study of some 113 medicinal plants of Izucar de Matamoros; while ZINGG (120) reported on 40 species (identified by P. C. STANDLEY) used by the natives of Chihuahua.

The correct identification of the species referred to by the Aztec writers and the later Spanish historians has been a fertile field for investigation. The studies on peyote and ololiuqui have already been referred to. RIVERA MORALES (67) has compiled a list of the botanical species cited by SAHAGUN giving both the vernacular and common names. BECCARA has discussed the identity of *huacalxochitl* (7) which is *Philodendron anisotomum;* and *iskishochitl* (8) which is *Bourreria formosa,* a species extensively cultivated today as jasmin del Istmo. GANDARA (21) has pointed out that whereas SAFFORD (73) correctly identified *xochinacaxtl,* an aromatic spice of the Aztecs, as *Cymbopetalum penduliferum,* the leaves which he figured are actually those of a different species, *Guettaria rufa.* SCHULTES (83, 87) has shown that *teonanacatl,* the narcotic mushroom of the Aztecs, is still used by some of the Oaxaca Indians. The species involved is *Paneolus campanulatus* var. *sphinctrinus.* This identification disproves the idea advocated by SAFFORD (74, 75) that *teonanacatl* was identical with peyote. JOHNSON (41) has presented brief data in regard to the present day use of this narcotic fungus.

TABLADA (102) has discussed briefly the important part that cacti have played in the

economic, social and religious life of Mexico and the resulting influence on Mexican art. Similarly, TORO (104) has shown the influence which the use of peyote and ololiuqui have had on art.

The medical knowledge of the Aztecs has been made available by the publication of the *Badianus Manuscript* (19), the only complete Aztec herbal known to have been written by the Indians themselves. LOPEZ VERA (46) has given a brief account of the more important medicinal plants of ancient Mexico; while MALDONADO KOERDELL (50) has presented a popular resume of DEL PASO'S old work on medical botany.

*Ethnobotany in Central America.* — Most of the ethnobotanical work in Central America has centered about the Mayas of Yucatan and adjacent Guatemala and Honduras. POPENOE (64) has discussed the useful plants of Copan in Honduras, distinguishing between the pre-Columbian species used by the ancient Mayas and those of more recent origin. THOMPSON (103), reporting on the San Antonio Mayas of British Honduras, has included a list of native and introduced species cultivated by the Indians. ROYS (72) has published an extensive summary of the botanical knowledge of the Mayas from a medical point of view. In addition to an imposing list of cures, the work includes a valuable glossary of Maya terms and a list of the plant species prepared by P. C. STANDLEY. HARPER (25) and BEQUAERT (11) have given brief accounts of the plants and plant products used by the natives of Yucatan. LUNDELL (47) has discussed the milpa system of agriculture and the plants utilized for food. COOK (17) has commented on two important Maya plants, the breadnut, *Brosimum alicastrum*, and the chicle, *Achras zapota*. BENEDICT and STEGGERDA have investigated the foods of the present-day Mayas and in connection with their account (10) suggest the possible species used by the ancient Mayas. LUNDELL (48) has discussed the vegetation of Petén and comments briefly on the influence of the ancient Maya civilization on the distribution of certain species. STEGGERDA (98) gives a detailed report on 25 medicinal plants and considers briefly 134 other species used by the Indians. He has also (99) listed 233 plants and 208 animals the name and uses of which were known to a single Maya Indian. In a later volume (100) STEGGERDA has treated of the agriculture of the Mayas. In one of the appendices data obtained in the field from the Indians themselves is presented for 100 economic species. This supplements the work of ROYS (72) based on old manuscripts, of STANDLEY (96) based on herbarium specimens and collector's data, and SHATTUCK'S (95) medical survey.

LUNDELL (49) has discussed the plants which were probably utilized by the old empire Mayas of Petén and adjoining lowlands. TOZZER'S (105) edition of LANDA'S "Relación de la cosas de Yucatan" treats briefly of some of the ancient Mayan species.

BLAKE (12) has presented a list of some of the species used by the natives of eastern Guatemala and Honduras, supplementing the native names with the botanical equivalent. CONZEMIUS (15) gives many interesting data regarding the Miskito and Sumu Indians of Honduras and Nicaragua, although the scientific names attributed to the plants are often open to question. Similarly DIESELDORFF (18) has presented a lengthy account of the medicinal plants used in the Department of Alta Veraba, Guatemala, but here again the identity of the species is often in doubt. POPENOE (63) has given a detailed account of *batido* and similar Guatemalan beverages. VESTAL (110) has studied the carbonized peduncle of a cucurbit found at Petén and concludes that it is *Cucurbita moschata*, thus affording additional evidence that this species is of Central American origin. WISDOM (115) in his work on the Chorti Indians of Guatemala presents a glossary of native and scientific names of the plants utilized, the identifications having been made by P. C. STANDLEY. PITTIER (62) in addition to his publications on economic botany in general has given a detailed account of the Biribri Indians of Costa Rica with brief references to food plants.

*Ethnobotany of the West Indies.* — Very few ethnobotanical investigations have been carried on in the West Indies. BECKWITH (9) has discussed some of the medicinal and food plants used by natives in Jamaica; and STEGGERDA (97) has treated briefly of the medicinal plants known to the natives of that island. HODGE (36) has investigated the plants used by the Dominica natives and this preliminary report will be followed by a more exhaustive work (37) by HODGE and TAYLOR which is ready for publication. WOODWORTH (117) has reported on the plants utilized by the natives of the Virgin Islands.

*Ethnobotany of South America.* — ARGENTINA: PARODI (61) is the author of a work dealing with the relationships between the present agriculture of Argentina and that of prehispanic times. Following a general discussion of the domestication of plants, a detailed account of the species utilized in native agriculture is presented. PARODI recognizes 3 main types of agriculture: *1.* the Inca type (by far the most important in Argentina) characteristic of the tropical and subtropical Andean region; *2.* the Guarana type, characteristic of the subtropical area of western Brazil, Bolivia and Paraguay; and *3.* the Araucana type characteristic of central Chili. STORNI (101, 101a) has published two works dealing with the food plants of the natives, including brief historical surveys of ethnobotanical investigations, phytoarcheological comments, a discussion of the 12 geoethnographic regions into which Argentina is divided, and a detailed account of the plants and animals with vernacular and scientific names. Some 82 native and 33 introduced species are utilized. MILLAN DE PALAVECINO (56) has discussed the source of dye stuffs and the relationships between the dye plants of Argentina and those of other areas.

BRAZIL: ANDRADE (3) has discussed nine of the more important dyes and dye plants used by the Brazilian Indians. DE CAMPOS (14) has presented notes concerning some 68 medicinal plants and 36 other species used by the natives of the interior of Brazil. NIMUENDAJU (58) has given an account of the cultivation and use of *kupa*, a food plant of the Canella Indians. Long supposed to be a species of *Dioscorea*, this vine proves to be a species of *Cissus*. DE ALZEVADO (2) has given a brief account of Brazilian food plants and medicines with résumés of previous work in this field and its importance.

BRITISH GUIANA: RODWAY (71) has given a fairly detailed account of the more important plants used for medicinal purposes by the natives of Guiana. Both vernacular and scientific names are indicated.

CHILE: GUSINDE (23) has presented an historical discussion and a list of 324 species used

medicinally by the Araucana Indians. Although listed under the common name, the scientific names are appended, together with references to literature and the use of each plant. LATCHAM (44) has discussed pre-Columbian agriculture in Chili in great detail.

COLOMBIA: MORTON (57) has investigated *yage,* a drug plant of southeastern Colombia and finds that three species are used under this name: *Banisteriopsis inebrians,* described as new; *B. caapi;* and *B. quitensis.* The use and effect of this narcotic are described. ARCHER (5) has reported that *quera* or *queda,* a useful plant of the Choco, proves to be a new species, *Schradera marginalis* Standley. The Citara Indians almost universally chew the young shoots of this species as a dental plant. ARCHER (6) has also published a brief account of the native species used by the Choco Indians for food, medicine and other economic purposes. These Indians, however, are becoming increasingly dependent on cultivated crops. SCHULTES in two papers (93, 94) has given a detailed account of *yoco,* the most important non-food plant of certain Colombian Indians, which has long been used as a stimulant. This plant proves to be a new species, *Paullinia yoco* Schultes & Killip. Yoco has a high caffein content (2.73%), but unlike all other caffein-plants the alkaloids are found in the bark.

ECUADOR: GILL (22) in a popular article has referred briefly to the more important drugs used by the Indians of the Upper Amazon. MARIN (51) has recounted under their native names many of the plants from which medicines are obtained in the Pastaza region of eastern Ecuador. VON HAGEN (111) in a general work dealing with the Tsátchela Indians of western Ecuador has devoted considerable space to the use of *achiote* (*Bixa orellana*) as a body paint and in ceremonies. He also discusses briefly the primitive agriculture, the use of caapi, and the source and use of the poisons toté (*Clibadium*) and barbasco (*Lonchocarpus utilis*).

The centuries-old practice among the Aymara Indians of Lake Titicaca of using the totara or tule, a native rush abundant in the marshes around the lake, in the manufacture of their canoes has long interested ethnologists. Several articles dealing with this subject have appeared recently. KNOCHE (43) has discussed the derivation and spread of these tule boats. BRINDLEY (13) has treated at length of these sailing balsas or canoes and other similar reed-bundle craft. In the author's opinion the Lake Titicaca balsas represent the highest stage in the reed- or grass-bundle type of boat construction in the New World. PARODI (60) supplements his account of the use of totara in the manufacture of canoes by pointing out for the first time the correct identity of the rush utilized. Referred to under many names in the past, it should be called *Scirpus totara* (Nees & Meyen) Kunth.

PERU: More ethnobotanical studies have been carried on in Peru than in any other South American country. Some of these investigations deal with the useful plants of the Incas and other ancient Peruvians as evidenced by the discovery of plant remains. The classic work of WITTMACK (116) in this field deals with such diverse subjects as cereals, legumes, fibers, fruits, vegetables, narcotics, spices and dyes. HARMS (24) has given us an excellent account of the species found in the graves, discussing them from a more strictly botanical standpoint. HARSHBERGER, also, (26) has given a brief and popular account of the more common species used.

The historical aspect of ethnobotany has not been neglected. YACOVLEFF and HERRERA (119) have presented a detailed account of the useful plants of the ancient Peruvians, quoting from original historical, botanical and archeological sources covering the years 1533-1703. The works of ten writers are included. The species are listed under both vernacular and scientific names and a systematic list of the plants is appended. Later, HERRERA (28) presented further quotations from eleven other old writers. The work of GARCILASO DE LA VEGA is especially interesting as it deals with a wide range of economic plants. HERRERA has adequately summarized our knowledge of the agriculture of the ancient Peruvians in a series of papers. In one of these (33) he discusses the domesticated food plants of the Incas, including such species as *Canna edulis, Chenopodium pallidicaule, Amaranthus* sp., *Lupinus mutabilis, Oxalis tuberosa, O. crenata, Tropaeolum tuberosum, Arracacia esculenta* and *Polymnia sonchifolia.* A second paper (34) deals with the endemic species cultivated; while a third (35) treats of 21 tropical species cultivated. These were probably introduced into Peru from the West Indies and Central America.

HERRERA has also been active in philological studies. A series of papers (27, 29, 32) dealing with the origin of the native names is of interest to ethnobotanists since in all cases the botanical equivalents of the vernacular names are given.

Among papers dealing with medicinal plants may be mentioned the following: FERNANDEZ MORO (20) has given a detailed account of the medical botany and zoology of the Madre de Dios and Urubamba regions. HERRERA (30) has presented an excellent account of the medicinal plants of Cuzco, giving their vernacular names, synonymy, characteristics, ranges, uses, and citing typical collections. MAZZINI (55) has discussed the plants used by the Incas in rituals and ceremonies as well as for practical remedies. WILLE (114) has outlined the history, cultivation and use of coca by the indians.

There have been many studies of individual species, genera or families. OYARZÚN (59) has discussed the antiquity of the gourd as a cultivated plant and ornamental plant product. YACOVLEFF (118) has given a detailed account of the history, cultivation and use of *Pachyrhizus tuberosus,* an edible root. VARGAS (106, 108, 109) has investigated the potato in Peru and treats of its origin and the varieties cultivated by the Indians. HERRERA (31) has studied the history and use of *quihuicha,* a common food plant of the Indians, and identifies it as *Amaranthus caudatus.* ANGEL (4) has reported on the history, morphology, origin, distribution and uses of the edible canna. VARGAS (107) has studied the *cañihua,* a native food plant of Peru and Bolivia, now also cultivated in northern Argentina. An excellent description of the plant is supplemented by references to its history, cultivation, uses, and varieties. The author points out that the species is *Chenopodium pallidicaule* Aellen, and not *C. canihua* as maintained by O. F. COOK (16). HUNZIKER (38) has published a complete taxonomic study of the edible species of *Amaranthus* and *Chenopodium* cultivated by the American Indians. Latin American species include *Chenopodium pallidicaule, C. quinoa, C. nuttallii* of Mexico; *Amaranthus caudatus,* and

*A. edulis* of Argentina. Species used in North America include *A. hybridus* var. *leucocarpus*, A. *powellii* and *A. retroflexus*.

Mention must be made of the ethnobotanical material scattered through the pages of the vast amount of literature dealing with arrow poisons and fish poisons. It is fortunate that in two cases bibliographies are available to which the reader is referred for further information. GILL (*22a*) has published a list of some 300 titles dealing with curare, the most important arrow poison of South America. ROARK (69, 70) has brought together over 500 titles relating to cube or barbasco. Modern investigations of this century old fish poison date only from 1924, when cube root was found to contain an insecticide. The toxic material, rotenone, was first isolated in 1929.

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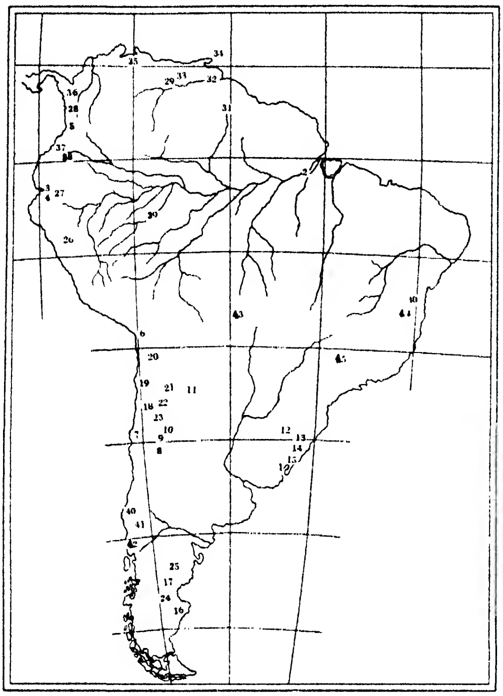
WM. C. DARRAH: **Paleobotanical Work in Latin America**: — LESTER WARD in 1889 published a monograph on *The Geographical Distribution of Fossil Plants* in which he was able to state only "vegetable remains have been discovered in Chile, the Argentine Republic, Bolivia, and Brazil." Then he followed this introduction with brief notes on scarcely a score of localities. Even more meager were his notes on fossils from Central America: NEWBERRY'S preliminary reports on Mesozoic plants from Honduras and Mexico, and a personal letter from WILLIAM FONTAINE concerning unpublished researches on Mesozoic plants from Mexico.

Indeed, knowledge of the paleobotany of Latin America is still sketchy. Nearly all of the reliable reports have been published within the twentieth century. There are three reasons why such very slow progress has been made. Firstly, explorations for commercially valuable



OUTLINE MAP SHOWING LOCALITIES FROM WHICH FOSSIL PLANTS HAVE BEEN COLLECTED AND DESCRIBED. — Some of these "localities" are composite, as for example at 43 from which at least five outcrops have been explored.

1/2, Devonian; 3/8, Lower Carboniferous; 9/15, Permo-carboniferous; 16/22, Triassic; 23/24, Jurassic; 25/30 Eocene (including so-called Upper Cretaceous and oligocene?); 31/45, Miocene-Pliocene.

The localities from adjacent islands such as the Falklands have not been indicated.

deposits of coal have proved disappointing. In general the search for petroleum has been more successful. Secondly, difficulties in travel due to rugged terrain, forest and jungle, and vast undeveloped regions have hindered large-scale exploration. Thirdly, there has been until recently comparatively little native interest in paleontological work, although at the present time, there is an awakening interest in the paleobotany of South America. A small but energetic number of local investigators have made noteworthy contributions to our knowledge.

Aside from the fragmentary records of early discoveries by D'ORBIGNY (1826-1833) published 1842, by DARWIN (*Voyage of the Beagle,* 1835), and HOOKER's reports on the Antarctic voyage of H.M.S. Erebus and Terror (1839-1843) published in 1847, little of permanent record found its way into geological literature before 1910.

The first major work describing a fossil flora from South America was published in 1908 by I. C. WHITE and DAVID WHITE on the Carboniferous of Brazil. This monograph established the previous reported but disputed record of an extensive *Glossopteris* flora in the western hemisphere. Furthermore, a few typical northern hemisphere carboniferous plants were intermingled with the characteristic southern flora. Also of interest in this flora is the curious Lepidodendrid known as *Lycopodiopsis derbyi.* RENAULT originally described this in 1879.

In point of time the next important publication, G. R. WIELAND's *La Flora Liasica de la Mixteca Alta,* appeared in 1914. This rich cycadeoid flora from Oaxaca, Mexico contains *Otozamites, Pterophyllum, Ptilophyllum, Williamsonia, Sagenopteris,* and *Cladophlebis.*

About 1915, E. W. BERRY commenced a long series of investigations on small scale collections of angiospermous plant fossils from many localities in Venezuela, Ecuador, Colombia, Argentina, Brazil, Trinidad, Mexico, etc. These many studies culminated in his *Tertiary Flora from Rio Pichileufu, Argentina* published in 1938. The overall value of this elucidation of the Cenozoic flora of South America, incomplete as it is, is inestimable.

The only other major works are: HALLE's *Investigations on Tierra del Fuego* and *The Falkland Islands* (1913, 1911), and G. R. WIELAND's *Cerro Cuadrado Petrified Forest* (1937).

*Fossil Plants of the West Indies: — Calcareous coralline algae* have been found at numerous localities in Trinidad, Curaçao, St. Bartholomeo, Anguilla, Martinique, and Antigua. The age of these deposits varies: the algae from Curaçao are believed to be Eocene, those of St. Bartholomeo Eocene, and others of later Tertiary age. The chief genera all corresponding to existing forms are: *Lithothamnion, Lithoporella, Lithophyllum, Corallina, Amphiroa,* etc.

*Silicified Woods:* — SCHEUCHZER in the *Herbarium Diluvianum* 2nd ed. 1723 (p. 102) reported *Lithoxylon ex Insula Antego.* This first record of West Indian plant fossils is of more than passing interest for in Antigua is situated one of the classic "forests" of petrified wood rivalling those of Arizona, Libya, Nubia and Patagonia. In the long history of the famous localities of Monk's Hill, Drew's Hill, and Constitution Hill, repeated references appear in geological literature, as for example in the first volume of the *American Journal of Science* (1818, p. 56). HENRY WITHAM (1831), WILLIAM NICOL (1834), FRANZ UNGER (1835-1840). HENRY WITHAM figured six specimens without adequate description but clearly recognized both palms and dicotyledons. NICOLS reported that he had examined a hundred specimens—mostly dicotyledons. UNGER described five series of palm woods. The only critical work on these woods was carried out by JOHANNES FELIX (1882, 1883) who recognized sixteen species belonging to *Leguminosae, Sapindaceae, Anacardiacea, Ebenaceae,* and *Palmae.*

Silicified woods occur extensively in Cuba. I have examined approximately ten species, all angiosperms from the Province of Camaguey, but these are as-yet undescribed. FELIX described at least two species of *Palmoxoylon* from Cuba.

In 1924, ARTHUR HOLLICK, published a review of the fossil flora of the West Indies in which he described 54 species of angiosperms—all being closely allied, *i.e.* cogeneric, with the existing West Indian flora. A few years earlier BERRY (1922) published on a small collection (Miocene?) embracing 9 species from Haiti. Included among these were *Chara woodringi* Berry and a fern assigned to *Gymnogramme.* In a still earlier paper BERRY (1921) described 13 forms, 12 dicotyledons and a putative grass, *Poacites.*

Many other features of Latin American paleobotany have been indicated in two articles

included in this volume: Brief Account of the Geology of South America (p. 318) and a Geological Sketch of Central America and the Antilles (p. 153). The bibliographies of these articles cover the general field adequately.

The accompanying map indicates the chief records of localities from which fossil plants have been collected and described. During the past four years systematic scientific exploration into the geology of Latin America have been in progress on an unprecedented scale. Virtually none of this newly acquired knowledge has been made public owing to the present world war.

*Carboniferous:* — Several occurrences of Carboniferous plants equivalent to the Culm-Lower Pennsylvanian of the North American continent have been reported from Argentina, Brazil, and Peru. The flora of apparent widespread distribution in South America (KURTZ, BODENBENDER, BERRY, and READ) is characterized by *Asterocalamites, Lepidodendrom, Cardiopteris* and *Rhacopteris.*

*Permocarboniferous Plants:* — The so-called Gondwana flora characterized by the pteridosperms *Glossopteris* and *Gangamopteris* is found in scattered localities throughout the southern hemisphere.

In 1870 HARTT reported *Lepidodendron* and *Glossopteris* from the state of Baía, Brazil. The identification of *Glossopteris* was not admitted by paleobotanists, until I. C. WHITE and DAVID WHITE published their flora of Rio Grande do-Sul in which *Lepidophloios, Gangamopteris, Glossopteris, Neuropteridium, Noeggerathiopsis,* and *Psaronius* predominated.

*Glossopteris* occurs also in the Falkland Islands, Mt. Weaver Antarctica, as well as various localities on the southern part of the South American Continent, especially in Argentina.

*Triassic and Jurassic Plants:* — J. S. NEWBERRY investigated small collections of fossil plants gathered in 1859 by Capt. MACOMB — Exploring Expedition from Santa Fé. The report finally published in 1876, indicated that a typical *Thinnfeldia* flora with *Otozamites, Taeniopteris, Pterophyllum,* and *Baiera* (*Ginkgoites*) occurred in Sonora, Mexico. NEWBERRY in 1888 published concerning a similar flora discovered 2,000 miles to the south in Honduras.

Reference has already been made to WIELAND's report on the rich flora of Mixteca Alta of Oaxaca, Mexico, geographically between those described by NEWBERRY.

Other upper Triassic and lower Jurassic plants have been found in Peru, Chile, and Argentina.

Perhaps the most significant discovery pertains to the Jurassic flora from Grahamland 63° 15'S, bordering upon the Antarctic continent. HALLE described 61 species collected from Hope Bay. The composition of this flora is interesting — 19 cycadophytes, 13 conifers, about a score of ferns, and several of doubtful position. The flora is a typical *Cladophlebis, Thinnfeldia, Otozamites, Williamsonia* association.

A small fragmentary collection of early Mesozoic age has been found on Mt. Weaver, Little America 86° 58'S.

The foregoing sketch of the paleobotany of Latin America may be summarized as follows:

*Chronologic*

1. Plant fossils from the Devonian to the present have been found in scattered parts of Latin America — from Mexico to Terra del Fuego.
2. The Permocarboniferous floras belong to the Glossopteris flora (Argentina, Brazil, Chile, Falkland Islands).
3. The Triassic is well represented in parts of Mexico, Honduras and at widely separated portions of the Andean province of South America.
4. Jurassic and Lower Cretaceous plants have a similar distribution and in addition Islands of Grahamland.
5. Upper Cretaceous angiospermous floras have been found in Brazil, Argentina, and Mexico.
6. Cenozoic floras, strikingly similar to the extant floras of the same regions have been found at many localities in Central and South America.

*Systematic*

7. Thallophytic microfossils have been found in a variety of fresh water limestones of Argentina (FRENGUELLI).
8. Mesozoic and Cenozoic coralline marine algae are found throughout the Caribbean region.
9. In northern South America so-called northern hemisphere "Arctocarboniferous" types intermingled with *Glossopteris* types.
10. Extensive Araucarian forests existed from the Triassic onwards, gradually diminishing in spatial distribution during the Cenozoic.
11. Members of the *Caytoniales* are found coextensively with Jurassic ferrugenous sediments.
12. Cycadeoids of striking variety have been found in Mexico, Honduras, Argentina, and Chile. The flora of Mixteca Alta is unequalled.

*Miscellaneous*

13. Oil Shales with microfossils occur in Brazil.
14. Coal of bituminous and high-ash anthracitic grades occur in the Permo-Carboniferous of Argentina, Brazil, Chile, and Bolivia.
15. Lignitic coals of Cretaceous and Cenozoic age occur in Colombia, Venezuela, Ecuador, Peru, and Bolivia. Commercial exploitation is on a comparatively small scale. Similar deposits occur in Central America.
16. Amber with plant and animal inclusions have been found in southern Mexico (Oaxaca). True copals have been reported from several localities in South America.

BOTANICAL MUSEUM,
HARVARD UNIVERSITY.

R. D. RANDS: **Hevea Rubber Culture in Latin America, Problems and Procedures*:** —

*Introduction.* — Increased production in the American tropics of *Hevea* rubber and many other non-competitive agricultural products needed by the countries of the Western Hemisphere is now widely recognized as the keystone in building inter-American economic solidarity. In 1940 the United States paid $318,000,000 for imported crude rubber, but less than 3 percent of this large sum went to Latin America. Naturally none of it was expended for research or other measures to promote rubber culture in Latin America, although most likely it included more than a half million dollars of "contributions" and special taxes levied by the Far Eastern exporting countries for these very purposes in those countries.

It has long been the conviction of many agriculturists that not only rubber, but in fact most of the tropical plant products brought from far corners of the world could well be produced in this hemisphere if given the same scientific at-

* This is a revision of a series of three articles under this title published in the *India Rubber World* for June, July, and August, 1942. — Grateful acknowledgment is made to L. A. BEERY, Jr., KARL D. BUTLER, T. J. GRANT, M. H. LANGFORD, and H. G. SORENSEN, agents of the U. S. Dept. of Agriculture in Latin America, for supplying experimental data on which some of the clone recommendations in this paper are based.

tention and business management they have received in the Eastern Hemisphere. The spread of war, disruption of trade routes, and final shut-off of Far Eastern rubber have at last crystallized such thought into coöperative intergovernmental programs. These include measures for the immediate emergency as well as for permanent agricultural developments, the latter designed to withstand the post-war economic repercussions.

A résumé of the broad coöperative plan for the establishment of an efficient and permanently self-sustaining rubber-growing industry in Latin America with a review of the progress to April, 1941, has been published by E. W. BRANDES, head pathologist in charge of Rubber Plant Investigations of the Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, U. S. Dept. of Agriculture (3)*. The undertaking, authorized by the Congress on June 22, 1940, met with immediate and widespread acceptance by all American republics having conditions suitable for *Hevea* rubber culture. Coöperative land surveys and development programs were initiated with the assignment of scientific personnel and contributions of funds or other assistance by the countries concerned. These activities, summarized in the above citation, included the collection and distribution of rubber-tree seeds, the establishment of coöperative propagation nurseries and research centers, the importation and distribution of the most adaptable *Hevea* clones from the East, and proposals for a closely coordinated intergovernmental rubber research program. Thus the organizational plan and activities have progressed to the stage of extensive field planting of rubber trees in a majority of the fourteen coöperating countries.

It now seems desirable to discuss some of the procedures and problems that have been encountered and are of interest to most countries. Frank expression of opinion, interchange of ideas, and teamwork will go far toward solving the problems in the shortest possible time. The methods and problems connected with growing rubber in Latin America are somewhat different from those of the East, but they present no insurmountable difficulty. Nevertheless the planting of a new crop of as many years duration as rubber, requires the most careful long-range planning and subsequent attention to avoid expensive mistakes. The land will be occupied for at least 20 years, and such a long period emphasizes the importance of proper initial consideration of such matters as size of the development in relation to costs and to other crops, choice of planting material, methods of land clearing, conservation of soil, planting, intercropping, disease control and other essential operations. The risks to be assumed in the beginning are of varied nature and magnitude, but in any case are greatly influenced by the type and size of the enterprise.

*Type of Enterprise.* — Many people in this hemisphere have the impression that all rubber in the Far East is produced on plantations operated by European companies with enormous initial capitalization. While it is true that European enterprise started the industry, it was not long before small local firms and individual native farmers took up the culture of rubber. Thus the rubber areas in most of the producing countries range in size from the numerous small, dooryard plantings to the relatively few large estates of many thousands of hectares.

Over the years it became evident that the owners of the smaller and medium-size areas of rubber were less affected than the large plantations by the extreme fluctuation and periodic depression in the price of the product. The former rarely were dependent upon income from rubber alone, but relied upon a number of crops which never suffered equally from low prices during periods of depression. Thus in parts of Java it was not uncommon to find the total area of a plantation apportioned among two or more of such crops as rubber, coffee, coconuts, sisal, kapok, tea and cinchona, depending upon the suitability of the soil, topography, altitude and other factors. Mixed cultures were likewise common. That of rubber interplanted in many existing coffee gardens will be referred to presently as promising for immediate trial in several of the American republics.

The advantages of crop diversification, catch cropping and even of mixed cropping under favorable conditions are widely recognized. They are mentioned here only to emphasize the need of better coordination and support of the many meritorious, but isolated, investigations of other crops which are important in connection with a successful Latin American rubber industry.

*The small-farm or one-family planting.* — Although necessarily slow in adopting improved practices, small-farm rubber culture is ideally suited to the basic, well-balanced type of agriculture characterized by individual land ownership and a sufficient diversity of crops along with animal husbandry to insure ample income, stability and permanence. Such also contributes, of course, to a more balanced national economy. In this case rubber may constitute only a "side line," or accessory source of cash income with little or no capital investment. It is scarcely influenced by availability and cost of labor and, therefore, is particularly suited to colonization projects or small individual land holdings. POLHAMUS (15) has emphasized the many factors favoring production of rubber by small holders in Latin America.

That the production of rubber from small areas is perfectly feasible is attested by the fact that nearly 50% of recent world production has come from more than a million "native gardens," the individual size of which averages from 0.38 hectare in Java to 2.58 hectares in Malaya. In the Dutch East Indies the native industry developed with but little governmental assistance and usually in districts removed from European plantations which might otherwise have served as educational centers. A typical small grower's establishment and his product are shown in Plates *22a* and *b*, respectively. However, the most progressive small-grower industry developed in the Malay Peninsula where it became more or less interspersed with well-managed larger units and was assisted through educational programs by the government. According to a 1941 report by VONK (28), the latter were carried out by some 37 Asiatic instructors who were two-year graduates of an agricultural school and were assisted by some 30 demonstrators in teaching the native farmers modern methods of budding, disease control, tapping and preparing rubber. There were also 14 govern-

* The numbers in parenthesis refer to "Literature Cited" at the end of this paper.

Plate 22a. — Native rubber grower's hut and rubber garden at rear, West Coast, Sumatra.

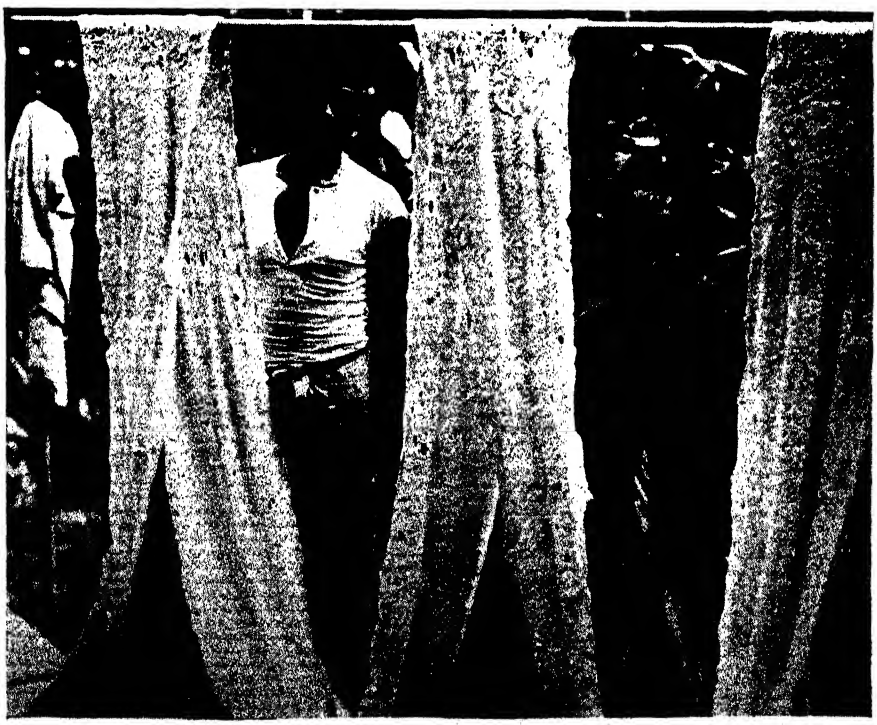


Plate 22b. — Crepe rubber from his hand-operated mangle drying in the open.

ment demonstration stations and budwood multiplication gardens.

An interspersion of large and small units is preferable for Latin America, as emphasized by POLHAMUS (15) and BRANDES (3). This assures more rapid general adoption of improved practices such as budding for the propagation of high-yielding clones in contrast with the indiscriminate planting of unselected seedling plants which alone were used in starting the Eastern industry. Initial company plantations can serve as sources of information and planting material, thus stimulating production by individual growers in the vicinity. The Goodyear Tire & Rubber Co. has constructed on its Costa Rican plantation, for demonstration purposes, a model one-family type of "factory" for coagulation of latex and preparation of Standard No. 1 quality smoked-sheet rubber. The simple and inexpensive equipment and detailed procedures have been described by W. E. KLIPPERT (12), manager of Goodyear Central American Estates. However in those districts not represented by a corporation-type enterprise the responsibility for the necessary educational and demonstration work will rest with government agricultural agencies. That such responsibilities will be met is illustrated by the program for Brazil, as described by CAMARGO (4) and MALLERY (14), and for Peru as outlined by SANCHEZ DEL AGUILA (20). Several other countries have published educational material on suitability of their land and climate, or procedures in planting *Hevea,* as for example in Guatemala by STANWOOD and TORUÑO (26), in Honduras by CORDOVA and STANWOOD (6) and in Mexico by MARTE GOMEZ and CONTRERAS ARIAS (5).

In Ecuador, Haiti, and Peru stimulation of rubber growing is being undertaken by local government corporations providing both educational guidance and financial assistance in the form of planting material or crop loans. The Haitian Government program is described by FENNELL (7). In Colombia, Costa Rica, Dominican Republic, Nicaragua, Panama, El Salvador, and Venezuela rubber planting is actively fostered by the respective Ministries of Agriculture through existing or newly established experiment stations and sub-stations. In all such programs designed primarily for helping the small grower much attention must also be given to other cash crops, as well as to food and sustaining crops, until the rubber at least will provide some income. Catch crops and intercrops are discussed later in this paper.

*The plantation enterprise.* — For medium-sized plantings (50 to 200 hectares) and large plantations, the amount of capital investment will usually demand sufficiently intelligent management to insure close contact with the experiment stations, extension specialists, or planters' associations. Therefore, these growers will not require much outside guidance.

BRANDES (3) has emphasized the significant rôle of pioneering plantation enterprises in each of the countries as centers for instruction and demonstrations. By selling seed, budwood, and budded stumps, by providing special milling and marketing facilities for the product of surrounding farms, and by conducting field experiments and demonstrations they serve as important links between the experiment stations and smaller growers. The well organized and successful plantations of the Ford and Goodyear companies in Brazil and Costa Rica, respectively, have already proved of immeasurable value as demonstration units for the host of official and private observers who desired to see modern methods of plantation rubber production in operation. The public-spirited interest and many years of effort of these companies to promote a Latin American industry, as well as the more recent activity of other American companies not yet possessing plantations in this area, are indicative of the widespread belief in the potential rubber-producing possibilities of tropical America.

Commercial firms and individual business men have frequently inquired as to what should be the optimum size of a plantation enterprise in order to afford competent and independent management that will handle all operations from the importation of supplies to the preparation and export of the rubber. This question cannot be answered, of course, by naming any particular figure; it depends upon a whole array of varying circumstances which need not be elaborated here. Perhaps some actual figures on the range in size of areas operated by Eastern rubber companies will suffice for the present. The Report of the Rubber Growers' Association of London for 1940 summarizes the data on British companies as follows:

*Acreages Owned by British Companies in Major Producing Areas:*

| COUNTRY | NUMBER OF COMPANIES | ACREAGE IN RUBBER | ACREAGE PER COMPANY |
|---|---|---|---|
| Malaya ....... | 357 | 1,344,615 | 3,766 |
| Sumatra ....... | 49 | 297,500 | 6,071 |
| Java ......... | 50 | 187,823 | 3,756 |
| Ceylon ........ | 95 | 159,997 | 1,684 |

This table shows the surprisingly small *average* total rubber area operated by individual companies. Furthermore a company's ownings are often divided among several widely scattered small "estates," as in Ceylon, for example, where, according to GEHLSEN (8), there are 876 estates with an average size of only 399 acres (162 hectares). Few, if any, of the smaller companies are independent in the sense of being self-contained operating units although they may be independently capitalized and directed. They depend upon a somewhat complicated estate agency system for their banking, brokerage, labor recruiting, and even general estate supervision through "visiting agents" in order to reduce administrative expense.

The obvious advantages of such a method for general business management will appeal to all small, locally capitalized rubber companies of Latin America. The present banking and shipping firms in the different ports could well install an estate or "hacienda department," with an experienced rubber administrator in charge, and for a small commission look after the general operations of a large number of individual properties. This is, of course, already being done where such firms are the sole or part owner of present coffee or other enterprises.

*Planting Material and the Problem of Leaf Blight.* — The most serious problem in the culture of the Para rubber tree (*Hevea brasiliensis*) in Latin America is the presence of the South American leaf blight caused by the fungus *Dothidella ulei.* This disease occurs throughout the native range of the genus *Hevea* in the Amazon Valley including, besides Brazil, parts

Plate 23a. — Contrast of susceptible Eastern clone (left) with selection from Acre Territory (right) resistant to leaf blight on the Ford Belterra Plantation, Brazil. —*Photo by* E. W. Brandes.

Plate 23b. — Young rubber in semi-hedge planting with miscellaneous natural vegetation as a ground cover, at Goodyear Speedway Estate, Costa Rica. — *Photo by* R. J. Seibert.

of Bolivia, Peru, Ecuador, Colombia, the Guianas and Venezuela. In early years it spread into plantings on the island of Trinidad and during the past decade has appeared in Panama and Costa Rica. Although during the coöperative rubber surveys of 1940 leaf blight was not found in Nicaragua, Honduras, El Salvador, Guatemala, Mexico and the island of Hispaniola, it remains an impending hazard in these countries to all present and future rubber plantings not consisting of resistant strains of the tree.

Leaf blight was responsible for the complete failure in 1912-1915 of the otherwise very promising rubber plantations of the British and Dutch Guianas and Trinidad. It spread from the scattered wild trees of *Hevea guianensis* and *H. confusa* (now considered a variety of *H. pauciflora*) in the Guiana jungles to the pure stands of the *H. brasiliensis* on the nearby plantations. Repeated defoliations exhausted the trees in their attempt to maintain a leaf crown with resulting die-back of branches and failure to yield appreciable latex. Seeds to establish these plantings had been imported from Far Eastern estates which recently, judging by the behavior of further seed importations, have again demonstrated their predominant susceptibility. STAHEL (25) made an intensive investigation of the disease in Dutch Guiana, but failed to discover any practicable method of field control.

*Early evidence of resistance.* — In British Guiana, between 1917 and 1921, several investigators (9, 18) reported observation of occasional trees which, judging by their outstanding growth and practical freedom from infection, were apparently resistant to the leaf disease. The observations of these men were repeatedly confirmed in 1923 by the present writer during a survey of abandoned Guiana plantations (17). At that time a considerable number of trees were found with healthy foliage, but closer examination often revealed evidence of earlier die-back so that the actual number in a given planting without such evidence, and thus apparently resistant, was exceedingly small. Nevertheless, the feasibility of controlling the disease by selection and propagation by bud-grafting only resistant trees was obvious and well-documented at the time, but lack of national interest in a western source of rubber discouraged any continuation of the project.

*Development of resistant clones.* — The Western Hemisphere is indebted to two pioneering companies for the initial demonstrations that rubber plantings can be successfully established in spite of the leaf blight. The first of these was the Ford Motor Co. which, in 1927, started plantations along the Tapajos River in Brazil; and the other, the Goodyear Tire & Rubber Co. with its experimental plantations begun in 1935 in Panama and in 1936 in Costa Rica. Both companies started plantations in infested districts without benefit of preceding research and development of resistant clones, as proposed above. This they realized so that initial plantings were confined to experimental size and progress warranting commercial expansion was necessarily slow. After the first discouraging years with leaf blight, no private concern with limited means would have continued these projects. They were popularly regarded as failures. By that time, however, the respective managements had already discovered, selected and propagated the occasional seedlings and selected strains of the tree that showed resistance to the scourge.

FORD had started the Fordlandia Estate by planting seeds collected from wild trees in the region about the plantation; later collections were obtained from several parts of the Amazon Valley, and still later many high-yielding Eastern clones were introduced. Eastern clones have not proved sufficiently resistant for use without crown-budding (referred to later) even on the more favorably situated Belterra Estate. Local clones have been established from many highly resistant and superior yielding seedling trees discovered after tapping the first plantings which originated from various amazonian seed collections. The resistance of these in comparison with Eastern clones is strikingly illustrated in plate 23*a* from the Belterra plantation. The severity of leaf blight on all susceptible plants, especially at Fordlandia, and the comparative freedom from disease of the more outstanding selections demonstrated the resistance of the latter. A. JOHNSTON, general manager, has supplied information for an account (10) of these plantations. More recently, J. A. RUSSELL (19) has summarized rainfall, geographic and economic data.

GOODYEAR first tried out many hundreds of high-yielding Eastern clones introduced as budded stumps from their Philippine plantation. Less than 1% of these were selected and thought to be sufficiently resistant to be considered for commercial planting even on the most favorable sites. At the same time, apparently resistant selections were made in the local grove of mature seedling trees on its Costa Rican tract, and systematic disease testing of clonal seedlings derived from Philippine seed importations was begun. Large shipments of these naturally cross-pollinated clonal seeds were planted yearly. Through the repeated epidemics of leaf blight affecting these nurseries a total of several hundred seedlings emerged with varying degrees of resistance, but always recognized by their outstanding growth in contrast with the dwarfed and defoliated seedlings surrounding them. The best of these selections have been multiplied as clones, but after prolonged exposure, the resistance of these was still insufficient to assure safe use. Therefore, crown budding of all Eastern selections and clones with highly resistant, Brazilian materials and direct planting of resistant Ford clones are relied upon for expansion of acreage. The history of the Goodyear Central American estates has been sketched in recent articles by W. E. KLIPPERT (11), local manager, and J. J. BLANDIN (2), vice president of the Goodyear Rubber Plantations Co.

*Intergovernmental Selection and Breeding Project.* — The foregoing briefly summarizes the significant progress of private companies toward founding a permanent *Hevea* rubber culture in Latin America. In June, 1940, the United States Congress provided funds to the U. S. Dept. of Agriculture for undertaking the present widespread coöperative program. This new project embraces not only research for improvement of present planting materials, but immediate practical arrangements for stimulation of commercial planting of existing resistant clones in all interested countries. Coöperation of the above-mentioned pioneer rubber-producing companies was immediately forthcoming, and active assistance was proffered by the larger banana-growing companies interested in finding substitute crops for the im-

PLATE 24. -- COVER CROP OF *Pueraria javanica* UNDER EIGHT-YEAR-OLD RUBBER ON FORDLANDIA PLANTATION, BRAZIL. — *Photo by* K. D. BUTLER.

mense areas of land which had been abandoned because of the wilt and "*sigatoka*" diseases attacking the banana crop.

Research headquarters of the U. S. Dept. of Agriculture for the study of leaf blight and the testing and selection of new clones have been located at Turrialba, Costa Rica and at Belém (Para), Brazil, in coöperation with the respective governments.

*U. S. D. A. Coöperative Rubber Plant Field Station, Turrialba, Costa Rica.* — This station is now fully equipped and staffed and possesses ample surrounding land for nurseries, clone collections and other limited plantings. Turrialba was selected as an ideal place for investigations of leaf blight, which occurs there, and for determining the resistance or susceptibility of all *Hevea* collections. Its elevation of about 560 meters in a valley subject to prolonged morning fogs for at least part of the year, its low night temperatures, and late-disappearing dews all favor the spread and severity of the leaf-blight fungus without the aid of much artificial inoculation. This combination provides a most severe test of resistance.

Both soil and climate are also representative of immense well-populated and healthful districts of Central America at intermediate altitudes where rubber of fully resistant type may be grown. At these elevations of 300 to 700 meters the trees probably will require a year longer to attain tapping size, *i.e.*, when about 75% of the trees have attained a girth of 50 centimeters at one meter above the ground. Thereafter yields should equal low elevation rubber according to comparisons available from Java.

*Los Diamantes Experiment Farm, Guapiles, Costa Rica.* — For the lower elevation experiments the Government of Costa Rica has provided the 1,000-hectare Los Diamantes Farm near the town of Guapiles, some 72 kilometers from Turrialba, now reached by rail, but eventually to be connected by highway. This farm is about 250 meters above sea level and is representative of the broad northern coastal plain which is highly suitable for *Hevea.* Plantings consist of budwood multiplication gardens, annual planting of row tests with clones established from resistant selections in the Turrialba nurseries, replicated plot tests with the best clones, clonal crossing gardens, and seed gardens. Propagation gardens to supply budwood for distribution to growers in all blight-infested areas are located here.

It is also in this coastal area near the town of Siquirres that the Speedway Estate of the Goodyear Rubber Plantations Co., is located. The coöperative investigational program with this company, dating from 1937, now aims chiefly at discovering superior new clones from seed collections furnished by this Department. A large commercial acreage of resistant Brazilian seedlings has been planted for this purpose. Propagating material of those selections which best combine resistance with superior yield will later be returned to Brazil and supplied other official agencies participating in the coöperative program.

*U. S. D. A. Coöperative Field Laboratory, Belém, Brazil.* — This is the official designation of excellent facilities provided the United States workers by the Instituto Agronômico do Norte at Belém, which is a part of the Brazilian National Department of Agriculture. Principal investigational projects conducted coöperatively with the Instituto's staff of specialists comprise (*a*) botanical and pathological studies of regional types, varieties, and species of *Hevea* and collection of budwood and seeds from superior "estrada" trees in major districts of the Amazon and its tributaries in Brazil; (*b*) breeding of superior yielding disease-resistant clones by intercrossing resistant selections under (*a*) as well as with susceptible high-yielding Eastern clones; resistance tests and selection of improved clones from material available under (*a*) and (*b*) and from special clonal seed progenies furnished by this Department.

Significant progress has been made on all of these coöperative projects, especially (*b*), under which the Institute arranged for immediate breeding work among the valuable collections on the Ford Belterra plantation. Under (*c*) this Department imported from the Philippines and Liberia more than a million hybrid clonal seeds for disease testing. Later there will be available hybrid seed for the isolation of superior new clones from breeding gardens in many of the Latin American countries, especially those remaining free from leaf blight where the susceptible but best breeding clones from the Far East may be readily crossed with resistant Amazonian selections. However, the best clones of the future probably will not be direct selections from the above-mentioned (*a*) wild collections, or (*b*) primary crosses but will derive from secondary and later generation intercrossings between the best clones from the primary crosses.

The pioneer Ford plantations on the Tapajos River have already demonstrated the commercial feasibility of selecting resistant strains for establishment of plantings in the Amazon Valley, as outlined in a foregoing section of this paper. To the corps of investigators now at the Instituto such an example provides a powerful stimulus and abiding faith in the nearly unlimited possibilities of this immense region. Resistant strains of *Hevea* represent the only practicable solution of the leaf blight problem, and this the Ford company has achieved with excellent chances of having the resistance combined with superior yield in many of their clones. Their best selections have been made available for general distribution not only in Brazil, but to this Department for the widespread intergovernmental coöperative program. These Ford clones at present furnish an important component of a satisfactory clone mixture for rubber planting generally.

Important contributions of superior clones are expected from other countries of the Amazon region, especially Peru and Bolivia, which reputedly also possess good types of wild trees as a basis for selection. Coöperative projects with Peru are located at Iquitos, Oromina, and Tingo María rubber stations.

*U. S. D. A. Coöperative Rubber Plant Field Station, Marfranc, Haiti.* — This station was established on land and with facilities provided by the Republic of Haiti. Its immediate purpose is the propagation of planting material for distribution locally and to the countries southward. Ultimately it will serve as a principal breeding station at which many of the leaf-blight susceptible, but excellent breeding clones of the East may be crossed with the best and highly resistant selections from wild trees obtained through the coöperative studies with Brazil, Perú, Ecuador, Colombia, and other countries

PLATE 25. — NATIVE RUBBER MANUFACTURE ON THE BANKS OF THE MADEIRA (*N. Brazil*). — *From* FRANZ KELLER, "The Amazon and Madeira Rivers," London, 1874 ("An earthen jar, without bottom and with a narrow neck, is set by way of chimney over a fire of dry urucury, or uanassú palm (*Attalea*) nuts, the smoke of which alone, strange to say, has the effect of instantly coagulating the caoutchouc sap, which, in this state, greatly resembles rich cow's milk. The workman sitting beside this 'chimney,' through which roll dense clouds of a smothering white smoke, from a small cababash pours a little of the milk on a sort of light wooden shovel, always careful, by proper management of the latter, to distribute it evenly over the surface. Thrusting the shovel into the thick smoke over the opening of the jar, he turns it several times to and fro with great rapidity, when the milk is seen to consolidate and to take a greyish-yellow tinge. Thus he puts layer upon layer, until at last the caoutchouc on both sides of the wood has reached 2 or 3 centimeters in thickness, when he thinks the 'plancha' ready. Cutting it on one side, he takes it off the shovel and suspends it in the sun to dry").

that are included in the Amazon and Orinoco River systems.

From present knowledge Haiti appears to have less chance of becoming invaded with leaf blight than any of the blight-free continental areas. When one realizes the millions of plantation trees from which the Eastern clones were laboriously selected, the advantages to be gained from combining this concentration of yielding and other qualities with the resistance of the Amazonian selections are obvious. Naturally, also, intercrossings among the local clones to increase both yield and resistance (if needed) will be carried on, and such will be more successful in the absence of blight to damage the tender flowers.

*U. S. D. A. Coöperative Rubber Plant Field Station, Tela, Honduras.* — This station utilizes the land, buildings and other facilities of the Lancetilla Farm, which was the earlier research headquarters of the United Fruit Co. in Honduras. It is operated under coöperative agreements with this company and with the Ministry of Agriculture of Honduras. The limited area of available land is devoted exclusively to budwood multiplication and clonal gardens. Two groves of mature seedling rubber trees planted in 1926-27 by the United Fruit Co. yield some 300,000 seeds annually which are used for production of root stocks. The trees are tapped regularly, and the latex is used in demonstrations of sheet rubber preparation on a small-scale or a typical and feasible one-family size of enterprise.

This station is a convenient headquarters for direction of coöperative projects with the Ministries of Agriculture of Honduras, El Salvador and Guatemala. The range of soils and climates in these republics necessitates well-distributed experimental plantings and other coöperative investigations. Freedom from leaf blight will permit a whole chain of strategically located breeding and seed gardens where the highly susceptible, but best breeding clones of the East may cross-pollinate with resistant materials. In Guatemala large coöperative field tests are planned with owners of several coffee fincas interested in converting low-land coffee areas into rubber or in achieving a permanent mixed planting of the two crops.

In Mexico coöperative projects are under way with the Ministry of Agriculture at the Campo Experimental del Hule, El Palmar, near the town of Tezonapa, State of Vera Cruz. Some 300 acres of mature seedling rubber trees near this station provide ample seed for production of root stocks needed for the immediate clone multiplication and planting program.

*Operation of the Coöperative Clone-Improvement Program.* — Activities of the previously described stations are closely coordinated with those in behalf of rubber of all the coöperating Latin American countries. The joint endeavor of governmental agricultural agencies and adequately financed rubber companies of all countries on a single united program is required to secure the best possible planting material and to guarantee most rapid advancement of the industry in all other respects. In no important item are the Latin American nations as heterogeneous as the rubber-producing countries of the Far East; yet the latter finally came to realize the mutual advantages of united action, free exchange of planting material and information.

The equitable sharing of all improved planting material among the American nations is based on the just reason that all countries should, and eventually will no doubt, play an important rôle in its production. The program, which is already well advanced, is illustrated in Figure 1. This is merely a diagrammatic attempt to show the relations between the widely separated, but mutually interdependent phases of this coöperative plant-improvement program.

In this diagram the U. S. Dept. of Agriculture, together with its principal coöperative field station in Costa Rica, is represented as a convenient liaison agency between the various countries in the assembling and testing of plant collections and the development of superior clones. This is designed to foster closer relations between the countries themselves and provide safe interchange of planting material without spreading the South American leaf blight and other diseases and pests to new areas.

Here the countries are grouped according to the occurrence of leaf blight which is the most important problem to be solved in developing better clones and a permanent self-sustaining industry. Most of the countries having districts now afflicted with this plague, *i.e.*, those in Column A. of Figure 1, are those possessing resources of wild trees with valuable qualities such as resistance which may be combined with the high yield of the Eastern clones in order to develop the highest type of cultivated variety. Some of these countries have important blight-free areas suitable for rubber and which, because of high mountain barriers, may remain free for many years. Obviously, their hazard of invasion is greater, however, than the more distant countries completely free from the disease.

The blight-free countries (Column C. of Figure 1) have the opportunity of utilizing the highly susceptible, but best breeding clones of the East for developing superior new clones with resistance to leaf blight to safeguard their plantings against damage from possible future invasion by this disease.

In order to do this they need to use the best and most resistant selections from the Amazon countries and subsequently have the seedling progenies from their breeding gardens tested for resistance in disease-infested areas. Thus the two groups of countries are mutually interdependent for most rapid progress in advancement of their rubber-producing industries.

*Tests of imported clonal seed.* — The first project outlined in Figure 1 is that in the first square of the middle Column B., inaugurated in 1940 by this Department. The object was to secure improved clones from imported clonal seed progenies by selection following blight-resistance tests. The feasibility of discovering superior resistant clones by this procedure had already been demonstrated through several years of trials by the Goodyear Tire & Rubber Co. on its Central American plantations. Its initial phase, the resistance testing, is naturally limited to the blight-infested countries. Through coöperation of the Goodyear Tire & Rubber Co. 96,000 clonal seeds from its Philippine plantation were imported and planted in November, 1940, at the new station at Turrialba, Costa Rica. A second consignment, amounting to 204,000 seed, was obtained in February, 1941,

and planted at Belém, Brazil, in coöperation with the Instituto Agronômico do Norte.

In September, 1941, through similar coöperation of the Firestone Tire & Rubber Co., more than two million clonal seeds were obtained from Liberia and divided for testing in the respective nurseries at Belém and Turrialba. The presence of large mono-clonal blocks of superior Eastern clones on the Firestone Liberian estates enabled collection of seed from abutting rows of trees where natural cross-pollination between clones would predominate. Hybrid seed progenies representing fourteen specific clonal combinations and a large supply of seed from mixed plantings of desirable clones were conditions so hinder the disease as to permit satisfactory growth of Class 6, or more susceptible plants, it is advisable in the present state of knowledge to set Class 5 as the commercial limit.

From the clonal seedling nurseries planted in late 1940 and early 1941, more than a dozen new clones were established from vigorous seedlings with tentative blight ratings of Class 5 or better. More than double this number of selections was anticipated in 1942 from the larger Liberian seed nurseries under test at Turrialba and Belém.

Improvement of testing methods in 1942 by M. H. LANGFORD at Turrialba quickly demon-

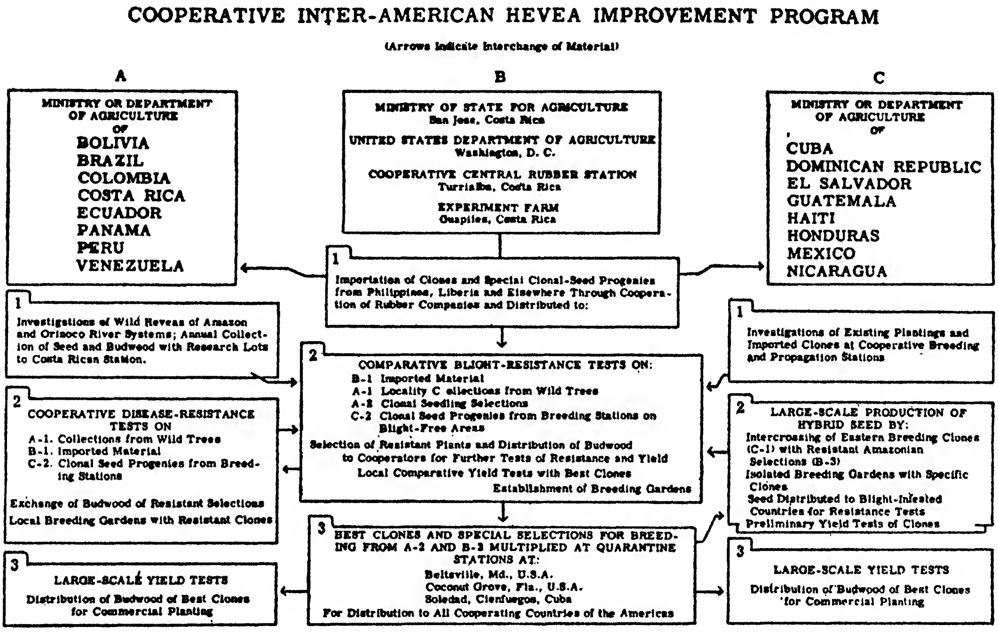



FIG. 1. — Diagram showing mutual interdependence of all coöperating countries in the development of blight-resistant and superior yielding rubber clones. Highly resistant selections from wild trees from countries in the left column (A) can be crossed with the highest yielding, but susceptible Eastern breeding clones in the blight-free countries at the right (C). Hybrid seed is then returned to (A) for resistance tests from which selections combining resistance with superior yield are available for safe planting in all countries.

represented in this first shipment. Those combinations showing the highest percentage of resistant seedlings, along with vigor and other desirable qualities, were to be emphasized in seed shipments of succeeding years.

In rating seedlings on resistance or susceptibility to leaf blight, ten classes have been described by M. H. LANGFORD, who is in charge of this work at the Turrialba, Costa Rica, station. Class 1 represents complete immunity, with no noticeable flecks of the disease on the leaves, whereas Class 10 stands for repeated and complete defoliation eventually resulting in death of the plant. Seedlings or clones falling in Classes 1 to 6 are selected for further tests although Class 6 plants are considered marginal for commercial safety in areas favoring the disease. Leaves of Class 6 plants show marked spotting, are somewhat dwarfed, deformed, or ragged, and a small percentage may fall off. This is the situation in the nursery under conditions favoring rapid spread and development of the disease. While experience may indicate certain localities where environmental strated that the previous estimates of resistance of these selections were too high. None emerged from the new tests with a rating lower than Class 8 which represents, of course, too great susceptibility for commercial consideration. Therefore, the initial promise of this source of selections, as outlined in the first edition of this paper, unfortunately cannot be realized.

Many Ford clones and other Amazonian selections, in parallel tests with the above, maintained Class 2 to 5 resistance ratings under the most severe conditions. These striking comparisons by LANGFORD emphasize the importance of immediate planting of breeding gardens as provided in the No. 2 squares of Figure 1.

*Breeding program.* — The problem of breeding superior new clones, combining high yield with high leaf blight resistance, is naturally simplified by the availability of the Eastern breeding clones even though they themselves happen to be very susceptible to the disease. The problem is further simplified by the fact that certain of these clones (listed presently

in the discussion of breeding gardens) transmit some resistance even to illegitimate seedling progenies.

The direction of arrows on the diagram indicates the annual flow of hybrid seed (when the gardens attain production) from the blight-free to blight-infested countries for resistance tests; and conversely the later return of selections as recompense to the seed-producing countries in order that all may plant safe material and share in the successive improvement of the crop. Emphasis is placed on the wide distribution of breeding gardens in the uninfested countries to avoid serious interruption of the program from accidental disease invasion and ruination of susceptible breeding trees in some of them. The provision of quarantine stations in B-3 of the diagram should enable safe transfer of budwood from the infested to uninfested countries.

Emphasis is here placed upon the great importance of utilizing the proved Eastern breeding clones for most rapid progress in obtaining superior planting material for the Americas. These clones transmit a concentration of factors for yield the duplication of which would probably require the growing, test-tapping and selection from millions of seedling trees such as the vast plantation areas where they were discovered in the East. They are the product of some 30 years of research, but have only been utilized to a relatively small extent in the Eastern program for gradual replacement of old seedling rubber. Not all high-yielding clones, however, transmit this yielding quality to a large proportion of their seedling offspring. Therefore, the few that have been proved to do so, through tapping results on their seed progenies from selfed or cross-pollinations, are especially valuable because of the many years required for such proof.

Crossing of these Eastern breeding clones with the highest yielding and most resistant selections of *Hevea brasiliensis* and the important other species from the Amazon countries will save much time in securing new clones which combine resistance with superior yield compared with attempts to select high-yielding trees in resistant seedling plantings. Many thousands of hectares of ordinary resistant seedling trees probably would be necessary in order to select many high-yielding clones. The rubber industry has advanced beyond the stage of planting unselected seedlings. Fortunately, a good number of selections of average or superior yield has already been discovered by the Ford Company among the comparatively limited areas of resistant seedlings planted on its Fordlandia and Belterra plantations in Brazil. However, the odds are against the finding of many very high-yielding clones if the history of Eastern selection work may be taken as a guide. Therefore, clones possessing very high leaf-blight resistance with moderate or average clonal yield will necessarily be used for crossing with the best Eastern material to increase yield and retain the resistance.

A breeding program may well follow the old and proved procedure with other plants of extremely variable or heterozygous nature. The resistant clone is crossed with the high-yielding susceptible one and resistant selections among the hybrids are then back-crossed to the susceptible parent in order further to increase yield, but if possible to retain the resistance. At each stage some of the highest yielding and most resistant selections will be of direct commercial value. The latter should also be planted in separate breeding gardens for free intercrossing. With *Hevea* even the first generation hybrids may be intercrossed without loss of vigor. Recombination and segregation of factors for yield and resistance will result in an intensification of both qualities in certain of the seedlings which may be discovered by test and represent a further step in clonal improvement. These particular breeding gardens can, of course, be located in all countries regardless of blight presence because they will be composed of resistant clones. Then, if the breeding qualities of the clones, especially the transmission of superior yield along with resistance, are sufficiently known, the clonal seed from such gardens might be used for direct commercial planting (without budding), such as is practiced already to some extent in the East.

Any plan for the breeding of *Hevea* is necessarily a projection for the future. Appreciable seed production only begins in the fifth or sixth year. Therefore the planting of breeding gardens should not be delayed.

*Clones recommended for breeding gardens.** — Two groups of clones are recommended for inclusion in mixed plantings to provide for optimum natural cross-pollination between susceptible and resistant components. Within each group the individual clones are segregated into lots of four each for pairing with a similar number from the other main group as follows:

GROUP 1. Far Eastern Breeding Clones (susceptible to leaf blight).

| *a* | *b* | *c* |
|---|---|---|
| GA 49 | GA 163 | GA 337 |
| GA 183 | GA 272 | GV 17 |
| GA 352 | GA 273 | GV 31 |
| GV 21 | GA 308 | GV 37 |

GROUP 2. Ford Brazilian Clones (resistant to leaf blight)

| *a* | *b* | *c* |
|---|---|---|
| FB 54 | F 170 | F 176 |
| FB 74 | F 211 | F 1619 |
| FB 110 | F 315 | F 1620 |
| FB 3363 | F 409 | FA 1707 |

The sub-grouping of the clones is partly arbitrary, but some classification is desirable unless all clones of both groups are to be indiscriminately mixed in a single planting. The latter procedure is undesirable for subsequent identification of the parents giving the most resistant hybrids found in the seed progenies without resorting to extensive hand pollinations. On the other hand, too little is known about the yield of the Brazilian clones to warrant duo-clone plantings. Therefore a compromise between the two extremes is tentatively suggested whereby in each breeding garden four clones of Group 1 are mixed with four from Group 2. This number should be sufficient to compensate for variations in time of flowering among the individual clones as well as possible uncongeniality between specific ones and thus secure a maximum of natural crossing. It would also permit thinning out the two to three lowest yielding or otherwise unsuitable Brazilian clones, leaving only the best for further cross-pollinations.

* The writer is indebted to plantation officials of the Companhia Ford Industrial do Brasil; to W. N. BANGHAM of the Goodyear Company; and to L. A. BERRY, Jr. of this department for some of the data enabling choice of these clones.

A further reason for sub-groupings is to take advantage of certain known characteristics which each sub-group or most of its members have in common. For example, some of the clones in Group 1*a* are known to transmit to their illegitimate off-spring some resistance to leaf blight, according to communications from W. N. BANGHAM, director of plantation research for the Goodyear Company, and recent field comparisons by M. H. LANGFORD, pathologist of the Bureau of Plant Industry, Soils, and Agricultural Engineering. GV 21 is reported to be less susceptible (rated in Class 8) than the remainder of the entire group (Classes 9-10). For their transmission of yielding and desirable qualities, GA 163, GA 308, GV 21, GV 31, and GV 37 are widely recommended as breeding clones throughout the Eastern rubber-producing countries.

The Ford Brazilian clones are grouped in part on the basis of geographic origin; Group 2*a* clones are from the lower river area centering at Belém; and Group 2*b* and 2*c* clones are choice Fordlandia selections from the Acre Territory and diverse up-river sources (according to unpublished data kindly furnished by the Companhia Ford Industrial do Brasil). The composition of these groups of Ford clones is expected to change greatly in succeeding years with increased knowledge about these particular clones and the many others from which they were chosen.

In order to compare the value of hybrid-seedling progenies obtained from natural crossings between sub-groups of Group 1 and those under Group 2, a total of nine isolated seed gardens is required for all possible sub-group combinations as follows:

(1) Group 1*a* × Group 2*a*
(2) Group 1*a* × Group 2*b*
(3) Group 1*a* × Group 2*c*

(4) Group 1*b* × Group 2*a*
(5) Group 1*b* × Group 2*b*
(6) Group 1*b* × Group 2*c*

(7) Group 1*c* × Group 2*a*
(8) Group 1*c* × Group 2*b*
(9) Group 1*c* × Group 2*c*

It is unnecessary that all nine gardens be located on the same plantation, in the same district, or even in the same country although it would be desirable to have most of them in each of the blight-free countries. If less than the full number can be planted, there is little choice as to which combinations should have preference. From the above discussion of sub-groupings, the combination 1*a* × 2*b* might appear most promising, but practically nothing is known about the inheritance of resistance to leaf blight. However, the differences between clones in degree of resistance indicates that it is determined by multiple factors, such as is true for yield; therefore any factors for resistance contributed by Group 1 clones might be needed if insufficient resistance is transmitted to the hybrids by the resistant Group 2 parents. However, the best parental combinations must also transmit good "secondary" qualities such as vigor of growth, good bark characteristics, resistance to wind-breakage and to brown bast. Therefore all the sub-group combinations should be tried. Furthermore, for the next step in the clone-improvement program it will be desirable to utilize outstanding selections from many of these first sub-group combinations in order to introduce as many divergent and valuable lines of inheritance as possible into the third-generation clones to be obtained by intercrossing among the selections themselves or back-crossing to the high-yielding parents.

*Location and methods of planting breeding gardens.* — Breeding gardens should be isolated from other rubber plantings to prevent introduction of outside pollen. The pollen of *Hevea* is sticky and is reported to be carried only by insects of which a species of bee is most important in the native habitat of the tree. Ordinarily no great isolation is required to keep out most of the stray pollen. A pollution of 10 to 15% derived from pollen of unwanted clones is of no great importance considering that the first use of the breeding-garden seed is for blight-resistance tests. Every resistant and otherwise desirable seedling from these seed progenies will

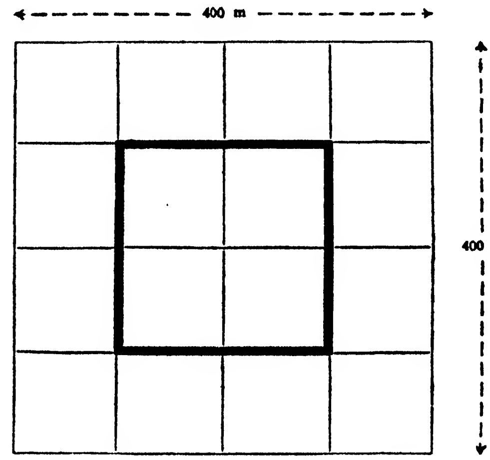



FIG. 2. — Scheme for establishing an "isolated" breeding garden within a commercial rubber planting. The same clones used in the central area are also planted in the surrounding "pollen barrier."

be established as a new clone and tested for yield even if the male parent cannot be traced.

Breeding gardens may be screened by leaving a surrounding strip of forest or jungle a few hundred meters wide. Such gardens in the early years are liable to serious injury from depredations of wild animals and also are likely to be neglected. It would be better to place these small gardens where they would be surrounded by areas of other crops such as coffee, coconuts, or cacao should any of these be grown on the same plantation. However, shading by such crops should be avoided because young rubber trees require plenty of space and sunlight in order to grow rapidly.

Where the above is impossible, or where rubber is the main crop, the scheme illustrated in Figure 2 suggested by D'ANGREMOND (1) is recommended. On a rectangular area of, say 16 hectares the chosen mother clones are put in a mixed planting, while later seed are harvested only from the inner four hectares enclosed by the heavy line. This inner area, therefore, is screened by a "pollen barrier" of the same clones 100 meters wide. The trees in the barrier are planted at the usual commercial spacing, and those of the same clones in the "isolated" area given a wide spacing for maximum seed production.

All isolated breeding gardens to be established in the early years of this coöperative program might well be planted at the usual commercial spacing to permit selective thinning of poorly developed individuals and poor breeding clones as determined by study of specific combinations through artificial pollinations. Thinning will also equalize or reduce too severe crown competition. On such questions as adaptation to climate and soils, little is known about the behavior throughout Latin America of any of the recommended clones in the two groups listed above. Therefore as breeding gardens may well constitute a part of the commercial rubber area of a plantation and be tapped as the remaining parts, no commercial sacrifice from very wide spacing should be taken for the sake of the extra quantity of hybrid seed for use in this particular clone-improvement program.

A semi-hedge type of planting in which the rows are about 6.4 meters (21 feet) apart and the individual trees in the row are spaced about 2.3 meters (7.5 feet) apart is recommended. This gives an initial density of about 680 trees per hectare (or 275 trees per acre). These include ample representation of resistant clones to continue the planting as a commercial area in the unfortunate event of leaf blight invasion and ruination of the susceptible clones. Approximately equal numbers of trees of susceptible and resistant clones should be alternated in each row according to the sub-group pairings listed above. Thus, for example, in the garden in which sub-groups 1*a* and 2*a* are to be planted for natural crossings the successive trees along the row would be GA 49, FB 54, GA 183, FB 74, GA 352, FB 110, GV 21, FB 3363, and so on, repeating until the end of the row. Of course a well-planned systematic shuffling of the clones whereby each one would occur a given number of times adjacent to every clone of the paired group might be devised, but this would require an accurate map of the garden to preserve the identity of every tree. It is essential that all trees of every clone be identified in the garden, and a simple repeated alternation will facilitate this and probably provide for ample cross-pollination of all clones.

*Clones Recommendend for Commercial Planting.* — Three groups of clones are listed and discussed as follows:

*Group 1:* Goodyear Eastern proved clones, susceptible to leaf blight but may be crown budded with resistant material, GA 49, GA 255, GA 308, GA 317, GA 337, GA 352, GA 1094, GA 1126, GA 1279, GA 1301, GA 1518, GA 1581, GA 2075, GV 21, GV 29, GV 31, GV 37, GV 42, GX 26.

*Group 2:* Clones resistant to leaf blight developed under the coöperative intergovernmental selection and breeding program outlined in Figure 5, such as the I.A.N. Series (Instituto Agronômico do Norte, Brasil), Tu. Series (Turrialba, Costa Rica, station) and other corresponding series to be designated in other countries as selection and breeding work are undertaken.

*Group 3:* Ford Brazilian clones of the Ford and Ford-Belem Series, resistant to leaf blight, as F 176, F 211, F 315, F 409, F 1619, F 1620, FB 54, FB 74, FB 110, FB 116, FB 3333, FB 3363, FB 3381, FB 3384.

*Group 1.* — Group 1 contains clones of proved individual yielding capacity of 1100 to 1600 kilograms of rubber per hectare per year at maturity according to test records of the Goodyear Rubber Plantations Company.

BRANDES (3) and POLHAMUS (16) have described the successive importations during 1940 and 1941 of Eastern clones from the Goodyear Philippine Estate. The last shipment arrived barely a month before the outbreak of war in the Pacific. These shipments contained two categories of material: (1) large quantities of budded stumps of about a dozen high-yielding clones which have shown slight resistance to leaf blight; and (2) a small quantity of budded stumps of each of 120 Eastern clones which are very susceptible to leaf blight, but possess other desirable qualities of value at least in the breeding program as described above. Recent experience has demonstrated that none of these Eastern clones is sufficiently resistant to leaf blight for safe commercial planting in Latin America. Nevertheless, they may be crown-budded with resistant material as practiced successfully by the Ford and Goodyear companies.

*Group 2.* — Group 2 as yet contains no clones of proved individual yielding capacity because of the brief period of operation of the coöperative selection, breeding, and testing program (Figure 1). Many resistant selections from apparently superior jungle trees are under test, and others from the coöperative breeding program are also being multiplied at experiment stations. However, several years must elapse before sufficient information will be available to enable specific recommendations.

Several series of clones in Group 2, obtained from imported Philippine and Liberian clonal seed, were discussed in the original edition of this paper as suitable for immediate commercial planting in mixture with Groups 1 and 3 clones. LANGFORD has demonstrated, however, that these clonal seedling selections derived from Eastern clones have not maintained their apparent resistance under most favorable conditions for leaf-blight. Therefore, safe utilization of these clones would require crown-budding with resistant material. This eliminates any advantage from their use since for the latter operation preference should be given the high-yielding proved clones of Group 1.

*Group 3.* — Group 3 clones, individually, are at present in the same unproved category as Group 2, although extensive data are already available on yield and other characters of the mother trees. Test tapping of budded areas on the Ford plantations during the next few years will reduce the size of the group and permit emphasis on the more outstanding numbers. A total of more than 70 Ford clones, selected mainly on outstanding yield, blight resistance, and other superior qualities of the mother trees, is now under test at the Ford plantations, and somewhat smaller totals at Belém and Turrialba. The fourteen numbers listed in Group 3, above, have maintained satisfactory resistance to leaf blight in the inoculation tests by LANGFORD at Turrialba, Costa Rica, and the mother trees are among the highest yielding on the Ford plantations.

In making these clones available for widespread planting, officials of the Companhia Ford Industrial do Brasil have emphasized that they are not necessarily recommending the clones because of their present unproved status. Never-

theless, the information generally supplied indicates their potential commercial value if planted in a manner permitting subsequent thinning out of any inferior numbers.

*Availability of planting material.* — From the above discussion it is clear that as yet only clones in Groups 1 and 3 are available for commercial planting. Many of the Eastern clones (Group 1) have already been multiplied extensively in the blight-free countries and also in a few blight-infested ones where multiplication gardens are protected by spraying to enable sufficient growth for crown-budding with resistant material in either garden or field.

The Ford clones (Group 3) have been multiplied during the period of their testing in blight-infested countries such as Brazil, Costa Rica, and Panama. Large supplies of budwood are being built up as a result of direct shipments. The latter are permitted only between infested countries through official intergovernmental channels and provide for most careful disinfection and packing of the budwood to prevent spread of insects and diseases from one country to another. Therefore, from the natural course of events the blight-resistant Ford clones (Group 3) have been multiplied especially in the blight-infested countries and, conversely, the high-yielding but blight-susceptible Eastern clones (Group 1) in the blight-free areas.

*Choice of planting material.* — Correspondence and conferences between representatives of the U. S. Dept. of Agriculture and officials of coöperating governments and private companies have resulted in general agreement that clones now available in both Groups 1 and 3 should be planted wherever possible in order to insure satisfactory yields and reduce the commercial risks. This involves mixing of equal numbers of clones from both groups in commercial plantings and of crown-budding all trees of the Eastern clones (Group 1). Crown-budding is discussed in a later section of this paper.

Since adaptability of the individual clones of either group to specific soil and climatic conditions is unknown, it will be safest to mix five to ten of the Ford clones with five to ten of the Eastern clones in each planting. All Eastern clones will be crown-budded, and if a sufficiently dense initial planting has been made, all trees of any low-yielding Ford clones can be thinned out without sacrifice of production per hectare. As soon as high-yielding numbers of Group 3 are identified or proved by test-tapping of budded trees, or similar superior clones are available from Group 2, commercial plantings can be made with selected clones from Groups 2 and 3 exclusively. In the meantime, a 50 percent proportion of Eastern clones, crown-budded with resistant material, in each planting will provide good insurance against possibly inferior yields.

*Field Planting System.* — In view of inadequate knowledge of the Ford clones, as explained above, close initial spacing of the trees in field plantings is desirable. An initial density of about 680 trees per hectare (275 per acre) should be sufficient, of which one-half, or 340 trees per hectare (137 per acre) would come from Group 1 and 340 trees from Group 3 clones.

A semi-hedge type of planting whereby the rows are about 6.4 meters (21 feet) apart and the individual trees are spaced about 2.3 meters (7.5 feet) apart within the row is recommended. A systematic mixing in every row of the clones from the two groups planted at this close spacing is very important from the standpoint of periodic thinning with age to prevent undue crowding, and for other reasons. Accordingly, individual trees of the two groups of clones would alternate within the row as follows: F 176, GA 49, F 211, GA 255, F 315, GA 308, F 409, GA 317, F 1619, GA 337, F 1620, GA 352, FB 54, GA 1094 and so on, alternating with representatives of Ford and Eastern clones to the end of the row. In succeeding rows the mixing is continued, but the group identity of the beginning tree should be preserved as a guide in determining which trees are to be crown budded should this be done in the field.

This particular density and system of planting are given only as examples believed to be suitable for the available planting material. A slightly different density and spacing might prove equally as good. However, it may be emphasized that the trend of experimental results during the last five to ten years in the Far East favors close initial spacing of the trees in the so-called "hedge" type of planting. The latter has obvious advantages for Latin America, such as cheaper land clearing, planting on contour, and economy of tapping the trees. Selective thinning is facilitated by having to consider gaps along the row only, and more trees per hectare with correspondingly higher yields can be maintained at maturity. The hedge type of planting is also most suitable where planting of other crops between the hedges or rows is planned.

A mixed planting of the above approximate density and composition should give good yields from the beginning of tapping which, depending upon the growth, may be after the fourth to sixth year in the field. It is also recommended that during the fourth year in the field, all deformed and stunted trees be removed and a test tapping on one-half circumference at a height of one meter above the ground be conducted every third day during alternate months for the first six months, *i.e.*, every tree should have had approximately 30 test tappings by the time it is 4½ years of age. From these test tappings an accurate latex-yield measurement should be stamped just above the tapping panel on each tree at mid-month of each tapping month. On the basis of these yields the stand of trees should be thinned immediately to approximately 450 trees per hectare. A further gradual thinning, over the next five years based on commercial tapping yields, should result in a final stand of approximately 250 to 300 trees per hectare. An initially dense mixed planting, therefore, ideally allows for weeding out the lower yielding or otherwise inferior clones, assures the best individual tree adaptation to local soil variations, and at the same time a satisfactory commercial yield.

A further advantage of a mixed planting with clones of diverse genetic origin will be its probable stabilizing influence on the leaf-blight fungus if and when the planting is invaded and the less resistant clones attacked by this disease. Under such conditions, with no two adjacent trees exactly alike, the fungus is less likely to adapt itself by developing specialized strains which would be able to damage seriously the initially resistant clones. A "commercially re-

sistant" monoclonal planting or a mixed one with closely related clones would be more favorable for such possible specialization of the fungus. Although such has not been demonstrated for the leaf-blight fungus, extensive evidence on similar diseases of other crops leaves little doubt that it could occur in this disease of *Hevea*. Therefore, the above suggested clone mixture represents good insurance for the future.

*Delayed Distribution of Resistant Clones.* — For the blight-free countries a period of waiting is unavoidable in order to secure safe planting material of Group 3. These clones are now growing under close observation at quarantine stations (listed in B-3 of Figure 1) from which during 1943, first shipments of planting material for rapid multiplication will be made to blight-free countries and important blight-free districts of infested countries, such as in Ecuador, Colombia and Venezuela. Therefore, until these valuable resistant clones can be multiplied and distributed throughout these countries where budding nurseries already have been established, only Group 1 clones will be available for planting. Seedlings for bud stocks from 1941 and 1942 local seed crops already far exceed the total number needed for the proportional requirement of Group 1 in commercial plantings of 1943. From the above discussion it is obvious that no commercial planting of more than mere test-plot size should be composed entirely of the susceptible Group 1 clones unless crown-budded. Yet the many closely spaced seedling nurseries now growing must either be budded during 1943, and the plants removed to the field or disposed of in some other way until ample budwood of Group 3 clones is available. This problem has been a subject of much correspondence. Two procedures are suggested, but a third is mentioned for trial on a small scale.

The first procedure is based upon the joint recommendation of the well-known Guatemalan agriculturist, L. LIND PETTERSEN, and the superintendent of the U.S.D.A. Coöperative Field Station at Tela, Honduras, E. T. STANWOOD. No doubt the same or modified procedure has occurred to others who have given close attention to the problem. In Honduras, Guatemala, Mexico and some other countries the seed crop matures near the beginning of the rather prolonged dry season, which requires the planting of seed in closely spaced nurseries for irrigation and low-cost maintenance. Here the seedlings are grown until the beginning of the following rainy season when they are transplanted to regular nurseries, or transferred to the field to the extent of requirement of Group 3 clones. Group 1, as far as available, would be multiplied in existing nurseries and any excess of budded stumps transferred to their apportioned and predetermined field positions. All remaining unbudded seedlings (the great majority) would then be stumped and transferred to the field for later budding at stake with Groups 1 and 3 clones as available. If budded at two to three years of age, the more rapid growth of such field buddings will tend to compensate the actual difference in ages in the field stand of trees. Naturally, as soon as budwood of both groups of clones is equally abundant, all budding could be confined to the nursery.

The second procedure available to the blight-free countries involves exclusive use of Group 1. These would be protected from leaf blight by high-stem or top budding with buds from highly resistant Belém seedlings now established in many of the countries, or with some of the resistant Ford clones to be utilized for base budding in procedure one. The method is outlined in the following section.

*Crown Budding High-Yielding Susceptible Clones with Resistant Clones.* — In addition to the selection of clones that best combine superior yield with resistance to leaf blight and other diseases and pests, the Ford Company (10, 24) has utilized extensively the so-called double-budding procedure. There results from this, an established plantation tree, made up of three genetically different components: namely, (1) an unselected or partially selected seedling root stock on which has been budded in the usual way (2) a high-yielding stem, but somewhat susceptible to leaf blight and certain insect pests and on this, at a height of about 2½ meters, is placed (3) a bud which develops into a vigorous, highly resistant crown. Part 3 may be selected only for its vigor and resistance, but other important qualities such as shape and "wintering" or leaf changing characteristics and resistance to wind breakage should be considered if alternatives exist.

Theoretically this procedure may be expected to more than double ordinary budding costs and delay somewhat field establishment as compared with the usual single operation. This will be justified, however, as insurance against blight. Wherever the procedure itself can be carried on successfully and suitable clones are used, there will be little doubt about satisfactory rubber production from the resulting composite tree. This is based on the known limited area of bark which supplies latex to the tapping cut; therefore, the principal indirect effects of a different crown on a high-yielding trunk might conceivably be some unimportant qualitative and quantitative change in the latex. Such should, of course, be investigated.

To the writer's knowledge, the possibility of a three-component rubber tree consisting of an ideal rootstock, an ideal stem, and an ideal crown was first suggested by CRAMER as recorded in 1926 by DE VRIES (29) in Java. In 1934, MAAS (13) reported some experimental crown buddings and emphasized the need of proper binding or supporting of the shoot after the successful bud patch union. His object was to prevent damage from *Oidium* mildew by top budding high-yielding susceptible clones with mildew-resistant, but low-yielding clones such as L.C.B. 870. This disease is not of annual or frequently recurring severity on young trees; thus there was afforded repeated opportunity and ample time for top budding the trees with a resistant clone during the first years in the field.

To what extent an opportunity of this sort may be permitted by South American leaf blight in the districts of Latin America where it now occurs is unknown. It is likely that many localities will so favor the disease that any susceptible clone would not make sufficient growth to permit crown budding. The fact that conditions have permitted extensive use of the method on the Ford Belterra Estate in Brazil is most encouraging and warrants careful study and climatic comparisons with other infested districts where its use might also be advantageous.

By demonstrating successful control of leaf blight in nurseries, budwood multiplication gardens, and young field plantings by application of fungicidal sprays, M. H. LANGFORD, pathologist of this Department, has provided a means for utilizing the double-budding procedure in all infested districts. This adds, of course, another item of cost in utilizing the known high-yielding but susceptible clones. However, as explained above, recourse to the double-budding procedure becomes a question of economic expediency to be weighed in relation to availability and promise of alternative planting materials.

In using the method, probably the base budding operation should be confined to the nursery where most economical spraying for control of leaf blight is possible. Budded stumps are then transplanted to the field and the susceptible young clonal plants protected, as necessary, by spraying with a simple knapsack sprayer carried by the operator. In a report on investigations submitted for publication LANGFORD describes the equipment, fungicides, and procedures. When the young trees are 1 to 1½ years old, they are top budded with a resistant clone at a height of at least two meters. One bud will be sufficient for securing a high percentage of "takes" if a favorable time and proper conditions are chosen. Then the top of the clonal stem is cut off and a new crown encouraged to develop from the high stem budpatch. In blight-free areas crown budding of all susceptible clones with resistant material for insurance against leaf blight is recommended. In a recent article SORENSEN (24) has described and illustrated crown budding as practiced on the Ford plantations.

For crown budding, several near-immune or highly resistant Belém or other Brazilian seedlings or clones are carefully selected. The following clones (among others) have been used satisfactorily on the Ford plantations: F 211, F 409, F 1619, F 1620, FB 54, and FA 1707. Indiscriminate mixing in the planting of at least a half dozen genetically different crowns is desirable to counteract adaptation or possible specialization and consequent damage by the leaf blight fungus which might otherwise occur on a mono-clonal canopy. The clones for crown budding should also, of course, be carefully selected on other characters, such as vigor, resistance to wind breakage and as to form in relation to prospective type of planting. For example, crowns with fairly narrow and sharply ascending branches are more suitable for close spacing in hedge-type plantings as well as for interplanting with coffee and other crops. Crowns of other species of *Hevea*, as *H. benthamiana*, *H. spruceana*, and *H. guianensis* are reported to have been used for control of both diseases and pests on the Ford estates. Extremely vigorous interspecific hybrids, if resistant to leaf blight, should also receive the same experimental attention for this purpose as the *H. brasiliensis* × *H. spruceana* hybrids have in Sumatra (21) for root stocks.

*Rotation Planting Scheme.* — In addition to the two methods just described, a third procedure is suggested for limited trial because of its possible merit as well as to enable immediate planting of Group 1 clones. According to this method, the crown-budded Group 1 clones would be planted in widely spaced hedges some 12 to 16 meters apart and later be interplanted with hedges composed of a mixture of clones from Groups 2 and 3 when these are available. Later, either group of clones could be cut out and the rows replanted with new high-yielding and resistant clones available by that time. Thus a changeover or convertible system is provided to take advantage of constantly more improved planting material or to meet possible disease exigencies.

SCHWEIZER (23), of the Besoeki Experiment Station in Java, and SCHMÖLE (22), of the A.V.R.O.S. Station in Sumatra, have recommended trial of this system in connection with hedge plantings where heavy thinning will be done. Thus, in closely spaced hedge plantings of 1 × 10, 1 × 9 or 1 × 8 meters every other row might be considered a "dummy" row which later, after severe tapping, would be replaced with newer and better planting material. This would permit renewal of the garden without loss in production. In the "dummy" or catch-crop row special seedlings and improved clones would be used, while in the other rows proved clones or better-known material would be planted. Thus, "dummy" rows alternate with "good rows" at a spacing of 1 × 20, 1 × 18, or 1 × 16 meters.

The very limited experimental data cited by the above-mentioned and other investigators in the East emphasize the speculative nature of this planting system. Since it is particularly adapted for mixed cropping, it could be tried out to best advantage in Latin America in unprofitable lowland coffee areas. This would involve replacing at suitable intervals present rows of coffee with hedges of *Hevea* representing the Group 1 clones and later removing an additional row of coffee between the first planted hedges to accommodate the clones of Groups 2 and 3. After a few years the remainder of the coffee with its shade trees would be cut out, leaving a pure stand of *Hevea*. A spacing within the hedge or row of two meters instead of one would be more appropriate with the planting material now available. For a permanent mixed culture of *Hevea* and coffee a much wider distance between the *Hevea* hedges than those given above would be necessary. This type of culture is discussed in a separate section of this paper.

From the brief outline of this rotation scheme, the need of some experiments is obvious. The theoretical advantages, however, apparently warrant some experiments to determine the suitability of present *Hevea* planting material, best spacing of the trees and the effect on yields of coffee or other temporary or permanent intercrops.

*Seed Gardens for Production of Root Stocks.* — The supply of readily available seed for budding nurseries is already becoming a "bottleneck" in rapid multiplication of clones in several Latin American countries outside the indigenous range of *Hevea*. Fortunately this problem is partially solved by what are commonly spoken of as the "failures" of previous attempts to establish rubber cultivation in these countries.

*Existing groves of trees.* — Many unselected seedling plantings of earlier years made with the expectation of their development into producing plantations still exist and are now composed of mature trees with large annual seed-production capacity. Reports of the Rubber

Survey in 1940-41 list a total of 23 groves in widely separated regions from Southern Mexico to Peru and ranging in number of trees each from a dozen to more than 20,000.

Secondary jungle and underbrush, crowding many of these abandoned plantings, have been removed, and the seed collected for establishment of nurseries. The remaining groves will also be utilized if possible under coöperative arrangements of the local governments with the owners of the trees. Application of fertilizers and other measures to promote maximum seed production are being undertaken along with studies to find the best methods for maintaining viability of the seed during local and long-distance transport.

Since budwood and budded stumps of the clones recommended for commercial planting have been distributed equitably to all cooperating countries prepared to use the material, a similar apportionment of seed for nurseries also has been achieved under the intergovernmental coöperative program. Thus, any excess above local requirements in a particular country may be exported to other countries less fortunate in their local seed supply. Local needs are readily determined by calculating the rate of multiplication of budwood of those clones to be used in commercial plantings. A multiplication ratio of 20:1 per year, plus 50% additional seed to allow for germination failure and poor growth, is commonly accepted in calculating root stock requirements. Since clones in Group 3 will not be released from quarantine and distributed to blight-free areas before the fall of 1943, only sufficient seedlings should be established each year as can be budded before they are three years of age. To plant more than this or to increase Group 1 clones, which have already been distributed beyond their proportionate requirement in the planned mixed planting, would be wasteful and to the disadvantage of other countries needing the seed unless, of course, the above-described crown budding of susceptible clones or alternative procedures should be followed.

Seed for nursery plantings in blight-infested countries, especially in the Amazon basin, is mainly a problem of organizing collection from wild trees in those areas which give predominately resistant seedlings. Otherwise spraying of the nurseries for control of blight epidemics is required. The feasibility and low cost of this has been demonstrated by M. H. LANGFORD, of this Department, whose experiments will be published during the current year. However the immediate establishment of seed gardens with resistant clones or seedlings should be undertaken to reduce future seed and nursery costs and assure a home-grown supply.

*New seed gardens.* — Seed gardens should be established in all countries in number and size proportional to potential rubber acreage or rate of contemplated expansion. Planting companies will provide their own requirements, but individual growers probably will depend upon seed merchants, community or district gardens. The last-mentioned could well be located on propagation and demonstration farms sponsored by government agencies.

In contrast with the relatively few breeding gardens, described above, the many widely distributed seed gardens should be composed only of blight-resistant clones or seedlings to avoid possible future difficulty and provide an abundant supply of seed for nurseries. Experimental evidence in the Far East indicates higher yields from clones budded on seedlings from high-yielding trees than from low-yielding or unselected trees. Therefore, local seed gardens containing a mixture of the presently available and highly resistant selections are recommended. A planting rate of about 250 trees per hectare to allow full crown development and early and maximum seed production is advised.

A coöperative program of experiments to determine the best source and type of root stocks has already been inaugurated in several of the countries. The need of such is emphasized by various reports from the Far East indicating the apparent increased value of a vigorous, high-yielding stock for promoting development and yield of the scion. In a recent extensive review of the subject, TOLLENAAR (27), in Java, states that increased yields from the use of a productive root stock instead of unselected seedlings in different experiments amounted to 20 to 40%. Therefore, good-growing and high-yielding hybrid seed progenies from outstanding clones such as AV 163, BD 10, Tjir 1, Tjir 16 and War 4 are generally recommended for production of stocks. Good vigor alone, however, apparently may increase yields. SCHMÖLE (21) of the A.V.R.O.S. Sumatra Station, reports five-year average yield increases of 14 to 33% for several clones budded on *Hevea brasiliensis* × *H. spruceana* hybrid root stocks in comparison with yields of the same clones budded on unselected *H. brasiliensis* seedling stocks. While these results were from a single small experiment, they indicate the need of further studies on the subject.

In order to investigate the influence of various root stocks on yield and other characters of the scion, seed from various species of *Hevea* have been collected in Brazil through the initiative of Dr. FELISBERTO C. CAMARGO, director, Instituto Agronômico do Norte, Belém, Para. Nurseries have been established at Belém and at coöperative stations in other countries. Some of the seedlings will be used directly as root stocks in comparative experiments; while others will be transplanted to isolated seed gardens along with comparable *H. brasiliensis* for inter-species crossing and production of hybrid seed for future root stocks. The same or different gardens also will be available for tests of top-budding and the broader investigations pertaining to miscellaneous *Hevea* species referred to earlier in this paper.

*Clearing and Preparing Land for Planting.* — In clearing jungle land for the planting of rubber without catch crops or intercrops the strip-clearing method, recently recommended in the East, is particularly suited to Latin America. The old method of "clean clearing" with complete burning of all debris, stumps and even excavated larger roots resulted frequently in soil deterioration without prevention of root diseases for which it was advocated. According to the new method all existing trees and undergrowth more than two meters high are felled or slashed and piled between the rows. In districts subject to a long unbroken dry season and where the amount of debris presents a fire hazard to the young rubber, a light burn as soon as possible to avoid destruction of surface litter and humus may be necessary.

Strips two meters wide and about 6.5 meters apart, center to center, are clean-cleared for planting the trees. When hillsides or slopes on which erosion might occur are being planted, the strips should follow the contour at the same uniform distance apart. Felled logs or stones, if present, should be placed along the lower side of tree benches or terraces on very steep land to prevent soil wash. Short stakes are used to mark the measured position for each tree along the middle of the strip, and jungle stumps are dug out only where they interfere with proper spacing of the planting holes.

After planting, the row strips only are kept clean especially of coarse grasses which are deleterious to the growth of rubber. On the rest of the area natural vegetation is allowed to grow with periodic slashing at a height of one to two meters. All native creeping leguminous plants are encouraged especially shade-tolerating legumes which may persist after the rubber trees are large. Seeds of desirable species may also be sown in any bare spaces.

Many agriculturists of coöperating Latin American countries have visited the Speedway Estate of the Goodyear Rubber Plantations Co. near Cairo, Costa Rica. There may be seen an adaptation of the latest Far Eastern methods of land preparation combined with semi-hedge rubber plantings, as recommended in this paper (*see* Plate 23*b*). Such field practices help to reduce the otherwise high labor costs of establishing rubber plantations.

A coöperative program of experiments on land preparation, planting and other field methods is now being inaugurated on the Los Diamantes Experiment Farm near Guapiles, Costa Rica. Similar experiments are needed in other countries having different soils, jungle cover and climatic conditions.

*Planting.* — Recommended procedures for field planting of budded stumps are the same as for budwood multiplication gardens on which mimeographed instructions have been issued by this Department as well as by many of the coöperating countries. Other circulars describe the establishment of nurseries so that neither of these subjects is discussed here. The semi-hedge type of planting, recommended spacing of the trees, and the number per hectare have been given under a preceding heading of "Clones Recommended for Commercial Planting," for which this particular planting system is especially adapted.

*Catch Crops and Cover Crops in Rubber Plantings.* — Catch crops are of especial importance to the small grower who must produce his own food and, if possible, some cash income during the three to four years before the planted rubber comes into bearing. If the land is not subject to serious erosion, catch cropping between the rows of rubber will do no harm, and often the attendant working of the soil is distinctly beneficial to growth of the young trees. In any case fairly clean clearing of the land and burning of debris are required.

Most of the common food crops may be planted between rubber. In native rubber districts of Sumatra and Borneo, a crop of upland rice is usually planted first and followed by banana, cassava, maize, various beans, sweet potatoes or other local food crops until the shade from the rubber renders further production impractical. Then a shade-tolerating leguminous cover crop is sown, or merely the weeds and spontaneous *Hevea* seedlings and other natural undergrowth are allowed to grow. However, a part of the new rubber planting may be devoted to cash crops such as *Derris eliptica* (rotenone), *Cymbopogon citratus* (lemon grass) for oil, *Amorphophallus oncophyllus* ("Iles-Iles") for production of mannan flour, and *Manihot utilissima* (cassava or mandioca) for sale to tapioca or starch factories.

For Latin America all of the above and many others are available for use as catch crops with rubber. However, just as with rubber itself, technical guidance and considerable investigation will be needed for successful development of these secondary, but highly important sources of cash income for the rubber grower. Each should be considered as a distinct agricultural industry in which the field phase merely utilizes the unoccupied and partly prepared land between the widely spaced rows of young rubber.

For the well-capitalized plantation enterprise catch crops may be of less importance so that consideration is given to the most economical maintenance of the plantings. A controlled, natural low-bush and vine type of soil cover supplemented by a planted cover crop not requiring much weeding will be the aim.

Many trials will be required to discover satisfactory cover crops for the various soils and climatic conditions of Latin America. An extended inquiry has failed to reveal local sources of commercial seed of even the best-known kinds anywhere in the entire region. The production of such should prove a profitable business for a few enterprising farmers in each of the countries. Collections are being built up and experimental work conducted at the Canal Zone Experiment Gardens, and a small collection of species is now under observation at the coöperative field stations of this Department in Costa Rica, Haiti and Honduras.

In Trinidad, Jack bean (*Canavalia ensiformis*) was widely used around 1917 as a cover crop for rubber. It was said to tolerate moderate shade, showed no disposition to climb the trees and the dense growth stifled all weeds and grass. The heavy crop of beans also furnished a palatable human food.

Velvet bean (*Mucuna deeringiana*) is another possible cover crop with subsidiary value as a forage crop. Various soybeans should be tried, both for temporary soil-cover following other food crops and for the edible oil, with the press cake utilized for cattle food.

The standard cover crops for rubber in the Far East, such as *Calopogonium mucunoides, Centrosema pubescens, C. plumieri* and *Pueraria javanica* (*see* Plate 24) also deserve widespread trial in Latin America. The first three species are, of course, indigenous to Tropical America, and the *Centrosemas* are probably most shade tolerant of all.

Cover crops without accessory value, such as furnishing edible seeds, may be more expensive to maintain than their supposed soil-improvement value warrants. Some may even retard growth of the rubber and suppress yields during a long dry season even though the row strip is kept free from growth and covered with a mulch of the slashings. Experimental comparisons of various species in the East have frequently given contradictory results. Without attempting to summarize the extensive publications, it may be stated that where cover crops have been diffi-

cult to maintain, a natural soil cover of spontaneous growth slashed back once or twice a year to a height of a meter has been found fully as satisfactory. However, singly or in mixture, the above-mentioned cover crops have sometimes greatly assisted in controlling the natural growths during the early years of the rubber planting.

The interplanting of rubber with other tree crops is a long-established practice in some Far Eastern countries, especially in middle and eastern Java. It is usually confined to areas of fertile soil where labor is abundant. Both coffee and cacao have been used extensively in the past as intercrops between the rows of rubber. However, rubber proved susceptible to the *Phytophthora* canker and pod rot of cacao which made that combination very undesirable. Thereafter kapok was substituted and proved a satisfactory combination with cacao, and coffee has continued as the principal intercrop for rubber. Despite unfavorable Eastern experience with *Hevea*-cacao mixed cropping, the combination should be tried at least experimentally in the American Tropics. The *Phytophthora* possibly may not prove serious because of some unknown differences in both climate and types of cacao and rubber used.

The similarity of soil and climatic conditions of eastern Java, where mixed cropping is very successful, with that of several of the Latin American countries having a similarly pronounced dry season warrants serious consideration of the practice in at least certain districts of the latter region. Rubber could be interplanted in present coffee gardens below an elevation of 600 meters, or new gardens started with a mixture of both crops. Thus about half of the customary coffee shade trees would be replaced by the *Hevea* which would not only furnish necessary shade for the coffee, but a remunerative product of its own. It might be well, therefore, to discuss briefly the advantages and disadvantages of such a system.

The primary motive for mixed cropping is, of course, to divide the economic risk, but a most important secondary one is increased income from a given area of land. The extreme fluctuations in price of rubber during the two decades prior to stabilization under international agreement demonstrated the wisdom of those having more than one crop to rely upon.

There, also, are advantages of a biological nature from growing two or more widely different crop plants in the same soil, for example, coffee with a shallow root system between *Hevea* with a deep one. Coffee is said to be practically immune to white root rot (*Fomes lignosus*), a serious disease of *Hevea* in the East, so that when the crops are planted in rows, the coffee tends to prevent spread of the disease.

The chief disadvantage is generally a reduced yield from each crop compared with unmixed plantings. This is usually attributed to the necessarily wider spacing and consequently fewer plants of each crop per hectare.

Under certain conditions, however, both light and root competition exert a depressing influence on yields. From the results of a comprehensive study of mixed rubber and coffee plantings in Java, SCHWEIZER (23) calculated rubber yields at 70 to 80% and coffee from 40 to 80% of those of unmixed plantings. With age the coffee showed a decline, although after 25 years under rubber in some gardens, it still yielded 40% of pure stands.

Coffee requires plenty of sun during the flowering and fruiting seasons, and the normal "wintering" or leaf-fall of *Hevea* may provide this added light if wintering occurs at the proper time. The two conditions are more apt to coincide in districts with a single pronounced dry season, such as the Pacific slope of Mexico, Guatemala and other similar areas where "low land" coffee is now cultivated. Another important factor is the value of *Hevea* as a windbreak for coffee in such mixed stands. Some coöperative experiments already have been arranged to study the various questions involved.

Questions regarding spacing of rows of rubber to be planted in existing coffee gardens both for eventual conversion to pure rubber and a permanent mixed planting have been alluded to in a foregoing discussion of a "Rotation Planting Scheme." In the complete absence of data from the Western Tropics no specific row spacings can be suggested. In any trials, however, the rubber should be spaced in hedge-type rows to permit satisfactory thinning with age. The rows of coffee should not be nearer than two or three meters from the row of rubber.

*Summary.* — This paper presents some details of procedure in fostering a rubber-growing industry and a discussion of problems under investigation in the coöperative intergovernmental program outlined in 1941 by E. W. BRANDES.

Measures are proposed and emphasis is placed on assistance to the small grower or one-family type of rubber planting. The use of selected resistant clones assures control of leaf blight and a yield enabling competition with other sources of rubber supply.

A diagrammatic outline is given of the intergovernmental selection and breeding project for the development of resistant, superior-yielding, and more widely adaptable clones for all coöperating countries. This involves crossings between the best breeding, although highly susceptible clones of the East with the most resistant and highest yielding Amazonian selections. The individual contributions and mutual interdependence of all countries for most rapid advancement of this project are emphasized.

The three coöperative field stations and other rubber research headquarters of this Department in Latin America are described with respect to their functions as centers for research and for the development, propagation and distribution of improved clones to all countries. Clones recommended for breeding gardens for production of naturally cross-pollinated seed are listed and suggestions for such plantings are presented.

Many new clones already have been established from resistant selections following blight-inoculation tests in nurseries planted with seed collected from various parts of the Amazon valley. These selections are being planted at experiment stations to determine their comparative yielding capacity and other merits for direct commercial use, or inclusion in the breeding program described above.

For commercial plantings, a mixture of two groups of clones is at present recommended, *e.g.* Goodyear Far Eastern proved clones which are susceptible to leaf blight, and Ford-Brazilian clones possessing very high resistance to

leaf blight. In areas infested with leaf blight the first group will probably need to be sprayed to control this disease until the trees are large enough for crown-budding with resistant material.

Closely spaced plantings of a mixture composed of some half-dozen clones from these different groups provide insurance against leaf blight, high initial yields and, with selective thinning, satisfactory production at maturity. A semi-hedge type of planting with an initial density of about 680 trees per hectare (275 per acre) is recommended as most suitable for the present and prospective planting material, as well as being most adaptable for intercropping.

Until the Ford clones have been sufficiently multipled in the blight-free countries for the suggested mixed plantings, several alternative procedures are suggested for safe and immediate utilization of the Eastern clones. These include pure or solid plantings in which every tree is crown-budded with highly resistant seedling material, and trials with a rotational planting scheme.

Suggestions are given for immediate establishment of seed gardens in all countries to provide an abundant future source of blight-resistant, home-grown seed for production of root stocks.

Methods of clearing land, planting, and the intercultivation of food and subsidiary cash crops until the rubber comes into bearing, or the use of leguminous cover crops and control of spontaneous natural vegetation for soil conservation and prevention of erosion are all briefly reviewed in relation to the most recent experimental work in the East.

Permanent mixed cropping of rubber with coffee appears sufficiently promising to warrant trial in several of the countries possessing suitable conditions. The absence of local information and consequent need of experimentation on this and many other subjects of importance in the establishment of a successful rubber culture in Latin America are emphasized as major projects for the coöperative inter-governmental research program.

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E. W. BRANDES: **Progress in Hemisphere Rubber Plantation Development*:** — Under authority given the Secretary of Agriculture by Congress in June, 1940, several logical steps have been taken to insure sound development of a plantation rubber industry in tropical America. From the beginning, active interest and cooperation by government and other agencies in 14 Latin American countries were freely given. The program was an ambitious one — nothing less than translocating half way around the world a measurable part of one of the largest agricultural industries. A better, more modern industry than the parent industries of Malaya and the Netherlands Indies was envisaged. The difficulties of the job were not underestimated. They had been brought sharply to the fore by the courageous pioneering of two commercial companies, Ford and Goodyear, who had started plantation development some years before in Brazil and Central America. Sifting and scrutinizing of the evidence already at hand, assisting in the correction of mistakes, and the perfecting of plantation planning and strategy were conceived to be a part of the contribution of the federal workers. It was hoped that in the field of biological science they would be able to make original contributions of practical value. It was appreciated that in such an undertaking, the

* Repr. from India Rubber World 108: 143-145 (8 text figs. omitted). — We thank the publishers of that journal for permission to reproduce this article.

directive force of scores of individuals would be taxed to the utmost and that success would depend upon the faith, ingenuity, and energy of many others. But in the minds of believers the game was worth the candle. The stakes appeared to be a secure source of proved, high-quality rubber, recognized by all as an indispensable material. Even at the reasonable costs estimated for producing the rubber it would add much to the purchasing power of our neighbors and customers south of the border.

*Development of the Program 1941-1943.* — In the first year technologists of the Bureau of Plant Industry, Soils, and Agricultural Engineering carefully nursed large quantities of superior, high-yielding *Hevea* trees across the Pacific from the Far East and surveyed the primitive backwoods of the hot countries for the most promising places to develop plantations. Simultaneously, experiment stations and nurseries were launched in cooperation with the governments and other agencies in Latin American countries to study the complicated biological problems involved in disease control and to multiply the tree material. Scores of tons of selected seeds have been moved from areas with a seed surplus to other hemisphere areas suited for the development of rubber plantations. Seed generously donated by Firestone was sent from Africa. In two years time some 25,000,000 seeds have been planted to produce seedlings on which to graft the superior, high-yielding strains. Last year a beginning was made in the development of producing plantations as an outlet for the nursery material, and it is estimated that a total of nearly 20,000 acres will be developed in 1943. That is just a beginning, but granting continuation of the sympathetic government encouragement it will grow to larger proportions. The interchange of plant material and other essential work go on despite unusual, disheartening obstacles due to wartime conditions.

During the second year a program of plant improvement by breeding and selection was started and has developed to the productive stage.[1] This contemplated utilizing wild trees having desirable characteristics, especially disease resistance, to supplement the high-yielding trees procured from the Far East. All of the multitude of trees in the East stemmed from a series of seed collections in an area that represented a mere fraction of the vast Amazon Valley, and represented only a part of the full range of variability of the tree in nature. In the present project a complete reference collection assembled by original collecting in all parts of the valley was planned. Shallow draft small boats were constructed especially for the use of technologists engaged in the collecting, which is now well advanced, but much more of the large area remains to be covered.

The pathological and plant improvement investigations have confirmed that South American leaf disease, which wrote the requiem for all early attempts to establish plantations in the Americas, is no longer a bar to success. This fungus disease, which spreads rapidly when susceptible trees are concentrated in plantations and which caused devastating epidemics in the past, can be controlled by using systems of protective measures demonstrated to be applicable to any part of tropical America.[2]

Table 1. *Summary of Hevea Plantings Based on Incomplete Reports from Cooperators*:* —

| Country | Seed planted in nurseries, number 1941 | Seed planted in nurseries, number 1942 | Estimated field plantings, acres 1942 | Estimated field plantings, acres 1943 |
|---|---|---|---|---|
| Brazil | 3,000,000 | 2,000,000 | 2 | 1,215 |
| Colombia | 212,000 | 180,000 | .... | 1,250 |
| Costa Rica | 1,776,000 | 1,300,000 | 1,200 | 1,300 |
| Dominican Republic | 1,000 | 86,000 | .... | 30 |
| Ecuador | 36,500 | 60,000 | .... | 50 |
| El Salvador | ..... | 20,000 | .... | 50 |
| Guatemala | 510,000 | 2,400,000 | 50 | 7,000 |
| Haiti | 3,600,000 | 125,000 | 1,500 | 4,000 |
| Honduras | 357,000 | 410,900 | 421 | 200 |
| Mexico | 1,000,000 | 1,500,000 | .... | 2,000 |
| Nicaragua | ..... | 105,000 | .... | 200 |
| Panama | 19,500 | 10,000 | 10 | .... |
| Peru | 23,000 | 200,000 | .... | 600 |
| Venezuela | 149,500 | ...... | .... | .... |

Details of the many biological problems that had to be considered and the ways in which solutions are being worked out must await a fuller account of progress. Certain tangible results, such as the number and locations of nurseries, types and amounts of plant material now on hand and the acreage of plantations being developed this year in several countries are shown in Table 1. Problems of a different nature such as the progressive deterioration of transportation services due to the war now confront the project. Because of the need of quick transportation of the perishable seeds, budwood, and budded stumps, often for long distances, air transportation is indispensable. It has become increasingly difficult to move by the available air facilities seeds and plants, procured and multiplied at considerable effort, and many large, valuable shipments have been so delayed that they arrived at destination in a worthless condition. Undue delay in handling live plant material, even when carefully packed is often extremely serious, causing interruption of parts of the program in some instances and postponement for a whole season in others. In dealing with crops the appropriate time for certain operations is dictated by the season, and if neglected or prevented, a year may be lost. Since the air transportation problem became acute last autumn, and after other possibilities were carefully explored, attempts have been made to secure the exclusive use of a cargo plane as the only satisfactory solution.

*Conclusion.* — It may be said that despite the difficulties of the times, essential progress has been made toward the objective. The necessity of using modern methods and improved planting materials has been firmly implanted in many receptive minds in the Americas; several serious biological problems such as disease do not present the terrifying aspect they once did. Material progress has been made toward disease control and toward the solution of other serious problems. The technical skills needed by planta-

[1] *Hevea* Rubber Culture in Latin America. R. D. Rands, India Rubber World, June, 1942, pp. 239-43; July, pp. 350-56; August, pp. 461-65.

* This table gives only projected field plantings which may be realized or may be exceeded during the year indicated. Assuming 60% germination of seed, it is evident that most of the countries now have sufficient nurseries and gardens for multiplying the high-yielding clones to enable more extensive field plantings in 1944 and later.

[2] Langford, M. H., Fungicidal control of South American leaf blight of *Hevea* rubber trees. U. S. Dept. of Agriculture Circular 686, 20 pp., illus., November 1943.

tion workers are being inculcated gradually, and, above all, a beginning has been made in translating into use the essential materials and methods on actual, producing plantations. This is essentially a long-time program, but it should be strongly emphasized that the plantation development project in Latin America has given support in many quarters to the stimulation of increased production of wild rubber needed during the war emergency. To many of our good neighbors the project gives tangible assurance of a continuing interest in a permanent industry and helps to justify immediate improvement in transportation and other facilities which otherwise might be long delayed or questionable.

The whole program has now reached the critical stage when conspicuous success, as opposed to half-hearted failure, hinges upon continued support, intelligent direction, and push. Given that, the final report can be written in terms of bales of rubber produced in the Western Hemisphere, thereby realizing the projections of a group of farseeing statesmen and scientists in all of the cooperating American Republics.

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J. C. Th. Uphof: **Certain Minor Rubber Producing Plants in the Western Hemisphere during Times of Emergency:** — The Tropics and Subtropics of the New World, harbor a number of species that should be considered as rubber producing plants during times of emergency. Not enough rubber can be produced from the cultivated species, among which comes in the first place *Hevea brasiliensis* being followed by the less important *Manihot Glaziovii, M. piauhensis* and *Castilla elastica.* It is needless to mention here the recently widely advertised *Parthenium argentatum* and the Asiatic *Cryptostegia grandiflora* of which considerable areas have been planted in this part of the world. Neither the available wild trees of these species could furnish sufficient rubber at the present. Our attention has therefore to be directed to those species that have sometimes proven to be a source of rubber and whose latex is occasionally gathered and is sometimes mixed with that of *Hevea brasiliensis.*

In the first place should be mentioned a number of species of *Sapium,* a genus belonging to the *Euphorbiaceae.* Most rubber producing *Sapium* species are trees, reaching a considerable height. The majority are native to South America. These species are *Sapium taburu, S. verum, S. hippomane, S. Pavonianum, S. pelota, S. Jenmani, S. stylare, S. Aubletianum, S. aucuparium, S. bogotense, S. hamatum, S. Marmieri* and some others that are less known. Some of these species are distributed over considerable areas while others are more endemic.

Though the product of some species is good, it has always been unable to compete with that of *Hevea* in normal times. A number of species grow in the same area as *Hevea* and the latex from them is quite often mixed with *Hevea* latex as an adulterant. Generally speaking the quality of the *Sapium* rubber falls within the *Castilla* range, rather than with the *Hevea,* but in the present crisis every species of rubber-bearing plant must be carefully considered. Some rubbers derived from *Sapium* species have well known trade names. That derived from *S. taburu* is called tapuru or Sernamby of Cameta; that from *S. verum* is named Colombia virgin or caucho blanco; likewise that derived from *S. Pavonianum. S. Jenmani* produces a rubber known as Orinoco scrap.

There is not only variation in rubber production and in quality of rubber between the different species, but there is also much variation between that of the different individual trees as would be expected. These differences may be inherited or they may be due to environmental conditions, facts that can only be determined by carefully planned experiments. A deeper study will be very beneficial.

In the same region as we find *Hevea brasiliensis* is *Hancornia speciosa,* an *Apocynaceae.* This small tree is the source of the Mangabeira or Pernambuco rubber. The plants are especially prevalent south of the Amazon region. Much rubber reaches the market via Bahia and Pernambuco. The product has often the shape of large cakes, called biscuits. Mangabeira rubber is sometimes mixed with that of other species. It is of interest to note that in this region occurs an other latex producing plant, namely *Micrandra siphonoides.* Its latex is known to produce a good, very elastic rubber. This latex, however, is seldom collected by the natives, because it does not mix with that of *Hevea brasiliensis* which occurs in the same forests.

Thus far a difficult genus to work with, is that of *Jatropha* from which in Mexico the chilte or Sinaloa gum is derived. There is no doubt that it is tapped from a species of this genus. There is thus far no certainty from which species it is gathered. Differences are made between highland and lowland chilte. Furthermore statements have been given that chilte is derived from about thirty different species, which no doubt is exaggerated, since in Mexico are known slightly over 30 species of *Jatropha* and among those are a number of species that have only been found in a very few localities. From other sources there are indications that chilte may be derived from *J. aconitifolia, J. angustidens, J. urens, J. tubulosa,* and *J. cardiophylla.* There are not only possibilities that other species may produce chilte, but also we may have to do with species that are thus far unknown to science, since many parts of Mexico have not been explored botanically. The latex coagulates readily in water without the addition of chemicals, like acetic acid, alum, etc. In some parts of Mexico the trees have been occasionally exploited commercially, though in normal times the product was never of much importance on the rubber market. On the average the latex contains 26 to 30% rubber and about 35% or more resin. Chilte by reason of its high resin content might be especially well adapted to certain particular products. Especially certain sections of the West coast of Mexico, among which the state of Sinaloa, may be of importance in the exploitation of chilte producing *Jatropha* species.

Among the species of *Euphorbia* are a number that have been mentioned as rubber producers. The most important among these is *E. intisy,* native to Madagascar. It produces the intisy or herotra. The latex is rich in rubber which is of good quality. Experiments with this species have been conducted in some parts of the United

States, though commercially there is not sufficient plant material available.

Probably next in importance to the African species is *E. fulva,* a native to Mexico. The plant is known as palo amarillo, also as palo colorado, palo cucaracha and papelillo. Its product is called palo amarillo rubber. The plant is a tree reaching a height of 8 to 10 meters. Its bark is smooth and yellow and received therefore the vernacular name of palo amarillo. Trees are found from Jalisco and Guanajuato and seem to prefer well drained situations along rough, rocky hillsides. Large numbers of plants are found at 1,500 to 1,900 meters elevation where there is an annual rainfall of 550 to 750 mm., with an annual temperature varying between 17 and 20° C. Trees do not thrive on alluvial plains.

This species which is in normal times a minor source of rubber, produces a latex that is rather difficult to separate the rubber from the resin. The rubber content is from 18 to 20%, while that of the resin amounts to 40%. It has been estimated that on the average about one liter of latex per tree may be tapped. The latex is yellowish white. Like that of many other *Euphorbia* species, the latex is very irritant, causing violent inflammation of the eyes. Therefore care should be taken when the trees are being tapped. Though the rubber may not be considered superior to that of plantation rubber, it is noteworthy that there is a considerable abundance of the trees in some states of Mexico. It has been claimed that when the rubber is mixed in suitable proportion with that of other species, especially with para rubber, it improves markedly the quality. When properly tapped, trees may yield again after three months. Three annual tappings when properly practiced may be considered for a period of about ten years. Latex has been collected in small pots, also in petroleum cans. Some of the latex coagulates on the stem which is removed with knives. It has been estimated that 100,000 trees produce about around 300,000 K.G. latex per year from which 54,000 to 60,000 K.G. of rubber and 120,000 K.G. resin may be manufactured.

Though these minor rubber producing plants may be of value during times of emergency, it is very difficult to foretell what the future may have in store. It will be therefore of utmost importance to study at the same time their possibilities for times after the present world conflict.

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WILLIAM PENNOCK: **Notes on Cinchona Culture:** — *The Cinchona nomenclature* is confusing. The species described by some taxonomists include as many as 20 or 30 variant types which other taxonomists regard as distinct species. The horticulturist is therefore at a great disadvantage in identifying his plant material so that others can tell what he is talking about. The plant material is of itself so highly hybridized and heterogeneous that even if the nomenclature of the separate, pure species were clearly and incontrovertibly established it would still be difficult to determine with certainty whether some individual plants were hybrids or whether their characters came within the limits of variation of a pure species.

We propose to follow the nomenclature of Dr. PAUL C. STANDLEY of the Field Museum of Natural History at Chicago. However when greater specificity is desired we propose to supplement the nomenclature with purely horticultural names. Dr. STANDLEY considers that only 2 *Cinchona* species are cultivated for quinine and cinchona bark production namely *C. officinalis* and *C. pubescens.* Both of these species contain many variant types. For horticultural purposes and for the body of this article we propose to use the terms:

"Calisaya type" to refer to plant material of the *C. officinalis* species of Bolivian or Peruvian origin with bark having quinine content of about 5 or 6 per cent (in terms of quinine sulfate heptahydrate). This material corresponds roughly to *C. calisaya vera* Wedd.

"Ledgeriana type" to refer to plant material of the *C. officinalis* species of the selection or strain of plants developed from the original Ledger seed in Java and having bark containing roughly from 6 to 16 percent quinine content. This material roughly corresponds to *C. ledgeriana* Moens but excludes similar strains of *C. officinalis* which may be found or developed in Bolivia or Peru or material which may have originated from these two countries after the Ledger seeds were obtained.

"Succirubra type" refers to all cultivated plant materials of the *C. pubescens* species and to identical material which may still be found in the wild in several countries. It arbitrarily excludes other types of the *C. pubescens* species which are not usually cultivated and conforms roughly to *C. succirubra* Pavon. The quinine content is usually from 1½ to 5 percent.

"Hybrid type" refers to plant material which shows marked evidence of, or is known to have originated from hybridization between *C. pubescens* and *C. officinalis.* The quinine content is highly variable between individuals but will range roughly from 1½ to 16 percent.

We realize of course that these terms are more or less arbitrary but believe they serve a useful function particularly with regard to horticultural discussions. Field labelling and plant records become increasingly a matter of differentiating between different selected clones which should be systematically numbered in some simple way. Doubtless, the horticulturist in charge will soon adopt the view that the specific botanical classification matters very little so long as the clone is high in quinine content and is otherwise desirable.

*Cinchona* cultivation is difficult and is generally attended by disease problems particularly root diseases and cankers. There is considerable difference in the hardihood of *Cinchona* plant materials. The succirubra types and the hybrid types, which frequently resemble them in appearance and sturdiness, are generally faster growing, more resistant to root disease, can prosper in a greater variety of soils, and can grow at lower altitudes than the horticultural types of the *C. officinalis* species. The ledgeriana type is the slowest growing and least vigorous of all the horticultural types mentioned here. The calisaya types are larger, more vigorous trees than the ledgeriana types but have more specific demands as to soil and climate than the succirubra and hybrid types.

*Selection of Nursery Area.* — The nursery area should be selected in flat or rolling terrain near to where it is intended to make permanent field plantings of *Cinchona.* The nursery site should have the following climatic and soil conditions:

(1.) Altitude from 4,000 to 6,000 feet. (This will, of course, vary somewhat with latitude,

but these figures are substantially correct for most tropical countries.)

(2.) Rainfall, roughly 200 to 250 centimeters, well distributed throughout the year.

(3.) Soil, light friable, loam or sandy loam, high in organic matter and with *good drainage.*

The following are also factors which would enter into the selection of a nursery site:

(1.) Availability of water for irrigation during dry periods.

(2.) Availability of sand for mixing with the soil and making suitable seedbed mixtures.

(3.) Availability of suitable material for shade for the nursery-beds (fern leaves, palm leaves, corn stalks, split bamboo, etc.)

(4.) Accessibility to roads for the transport of materials.

*Seed-Beds.* — By far, the most difficult phase of *Cinchona* cultivation is the seed-bed and nursery practice previous to setting out the plants in their permanent field locations. This work includes the propagation of high quinine content trees as seedlings or as grafted plants. In either case, it requires painstaking care and highly skillful gardening. Whether for *C. officinalis* or *C. pubescens*, seed-bed practice is very much the same. *C. officinalis*, and more particularly the ledgeriana type, is more delicate and greater pains should be taken when working with this species.

*Cinchona* seed generally begins to germinate in about 30 days from seeding; continues to germinate at a rapid rate until about 60 days from seeding, when roughly about 90% of the seed will have germinated; and thereafter, some slight germination occurs until about 100 days from seeding when germination is complete or almost so. The speed of germination and subsequent growth is greater at warm temperatures than at low. The above schedule of events as well as other time relationships mentioned later, may be regarded as the average for the climates and altitudes recommended for *Cinchona* culture. The fundamentals of seed-bed practice consist of broadcasting the seed on the seed-bed surface; maintaining the seed-bed continuously damp and dark during the 60 days' period during which the bulk of the germination occurs; thereafter, reducing the moisture content of the soil and increasing light gradually so that the plants will not be attacked by damping-off (salcocho) and will gradually become sufficiently hardened so that they may be transplanted to the nursery.

In practice, these fundamentals may be carried out more efficiently by using a type of seed-bed and seed-bed shelter especially developed for *Cinchona*. It consists in brief, of a seed-bed one meter wide, about 15 centimeters deep and any convenient size in length (15 to 20 meters). The seed-bed is covered with a rain-proof shelter, preferably of corrugated iron (lamina de acero corrugado) to insure absolutely against the rain dripping through and uprooting the plants and otherwise spoiling the seed-bed. The roofing is placed at a steep slope (roughly about a 45 degree angle), with the higher side being about 2 meters from the ground level and the lower side about half a meter. Sheets of 8 feet (2.40 meters) length are used for the roofing so as to insure considerable overlap to serve as eaves to protect the seed-bed from wind driven rain. The high side of the roof should face due north so that the plants may receive indirect sunlight from the north when it is desired to give them more light. In regions where strong north winds prevail, a strip of transparent cloth should be tacked up across the front of the bed to protect the plants from wind driven rain. *The orientation of the seed-bed cannot be too strongly emphasized. In practice, seed-beds should be oriented by actual compass reading.*

Seed beds of the type as described above were first built by the author in Guatemala in 1940. A few minor improvements were made in later models. Galvanized iron roofing was used rather than shingling and the bed was moved farther back under the shelter so that it was snug against the uprights supporting the low side of the roof. This allowed a walk between the front uprights and the bed which was very convenient. The narrowness of the bed facilitates weeding and makes it easy to give all the seedlings approximately the same light conditions. The partitions in the seed-bed were placed there to mark off the plants in an experiment. They are, however, a desirable feature in all seed-beds because they provide a barrier against the spread of damping-off.

The seed is broadcast over the surface of the seed-bed soil at the rate of 2 grams per square meter (roughly about 3,000 seeds). Before sowing, the soil surface is thoroughly wetted so that the seed will stick to it and immediately after sowing, the surface is again watered carefully with a fine watering can so that the seed is plastered down against the soil surface and cannot be blown away by the wind.

Watering is possibly the most critical operation in seed-bed practice. The watering can should have a *very fine spray* and when the water is applied to the surface, it should be applied gradually, so that the water is absorbed into the soil immediately and does not wash over the surface of the soil. Such washing would tend to carry the seed and accumulate it in the low parts of the seedbed, leaving the high parts empty. Moreover, it would also dig up recently germinated seedlings, killing them by mechanical injury. As mentioned above, watering should be frequent (about once or twice a day) during the first 60 days following seeding.

After 60 days from seeding, the frequency of the watering should be decreased. Specific instructions as to this cannot be given, because the moisture relationships depend largely on the weather. The gardener in charge of the seed-beds should be asked to use his own judgment with respect to the frequency of the waterings which should be given roughly at intervals of once a day, or once every 2 days, depending on circumstances. The important thing is to reduce the moisture content of the soil and surrounding air to the point where damping-off does not occur, and yet so that the plants will not be injured by lack of moisture. *It is much the safest procedure to risk injury from having the soil too dry rather than damping-off injury from excess moisture.* The depth and extent of the roots of seedlings in this stage is surprising; they resist drought much more than one would think. At 100 days after seeding, watering should again be decreased to some extent, and finally, at about 150 days after seeding, the watering recommendation would consist of allowing the seed-bed soil to dry out on the surface and to a depth of about one centimeter be-

tween successive waterings. If damping-off should occur at anytime in the seed-bed, it is an indication of excessive moisture; suspending the watering and decreasing the shade are the best means of combatting this disease.

Shade control is another critical operation. During the initial 30 days, the seed-bed should be in almost complete darkness. The shade should be lightened somewhat 30 days after seeding; again lightened somewhat at 60 days; and again at 100 days, and then finally, after about 150 days from seeding, all shade except the lamina roof should be removed. In the seed-bed shelter described above, the almost complete darkness which is desirable at the time of seed sowing is obtained by thatching over both sides and both extremes of the seed-bed shelter using palm fronds or similar shade material. With shade control as with watering, recommendations cannot be made that are too highly specific, but must be left to the judgment of the gardener in charge of the seed-beds. In general, it may be said that the main purpose of the shade is to avoid direct rays of the sun from coming in contact with the tender plants and also to cut down evaporation and obviate the necessity of watering even more frequently than has already been recommended above. After the 100-days period, it is the best plan to risk excess light rather than excess shade. However, direct rays from the sun should not be allowed to come in contact with the plants. This is why the seed-beds are so carefully located with the open side towards the north, so that the plants may be subjected to indirect light. Direct rays of the sun actually burn or scald the leaves of young plants with an injury that may be readily recognized once one has become familiar with it.

*Transfer of Seedlings from Seed-Bed to Nursery.* — There are several alternate practices in shifting seedlings from the seed-bed to the nurseries. With one scheme (which I consider the most desirable in the case of *Cinchona officinalis*), two successive shifts are made: First to a close spacing of 4x4 or 8x8 cm., depending on size, and later to another nursery at a wider spacing of 15x15 cm. With another scheme (which I consider more suitable for *Cinchona pubescens*) the plants are allowed to attain greater size in the seed-bed and are transplanted directly to 15x15 cm. spacing. Following the first scheme, transplanting is begun about 150 days after seeding. Only the largest plants about 5 cm. tall and having 3 to 4 pairs of leaves are used; these are transplanted to a nursery with waterproof cover and spaced at 4x4 cm. This transplanting in which very small plants are used is a delicate operation and requires great care. The plants themselves are much more easily transplanted with fewer losses if they are allowed to grow to a height of about 10 cm. However, ordinarily, when good germination is obtained in a seed-bed, it is desirable to thin out the stand in the seed-bed as early as possible and for this reason transplanting is begun with smaller more delicate plants. When working with these small plants, particular attention should be given to the texture of the soil used in the nursery-bed and to the extent to which it is watered and tamped. Fine texture soil should be used and tamping in advance of the planting should be sufficient so that when the planting itself is accomplished, the soil particles will be in close contact with the roots of the small plants. This is again a detail of great importance but one which every good gardener who is used to transplanting small, delicate plants, should be familiar with.

Thorough, careful watering should follow the transplanting without fail. It will be noticed that the original seed-bed from which some plants have been transplanted will shortly become crowded again because of increase in size of the remaining seedlings. Frequent transplantings will have to be made in order to avoid overcrowding. These transplantings are continued at approximately monthly intervals until most of the plants which are left in the original seed-bed attain a size of 10 to 15 cm. or more. At this stage about 200 to 250 days following seeding, almost all of the remaining plants in the seed-bed may be transplanted to a nursery at 8x8 or 15x15 cm. spacing. When the plants attain this size they may be moved to a nursery that does not have a waterproof shelter, the plants being sufficiently large to withstand a certain amount of the packing and pounding action of the rain on the soil. However, this again is a matter for the judgment of the gardener in charge of the nurseries, because so much will depend on how extreme the action of heavy rain may be in the region where the nursery is located. It may be mentioned, however, that the construction of the shade covering for nurseries may help considerably in reducing the severity of the drip action of rain. This nursery cover (very similar to that used in cover for coffee nurseries) can preferably be placed low, at a height of one meter or less above the soil, thus reducing the distance and, therefore, the force with which drops will fall from the cover to the nursery-bed. The spacing in the nursery is for the most part a matter of economy in nursery space, particularly in the type of nursery with waterproof shelter. It is a good plan when working with the ledgeriana type seedlings to have available nursery space with waterproof shelter (lamina) twice as extensive as the space which is included in the original seed-bed.

When the plants attain a height of about 15 cm. or more, they may be moved to a nursery at 15x15 cm. spacing, this being the nursery in which the plants will be hardened off and grown to sufficient size for planting out in a field in their permanent location. In about a year and a half to two years from the time the seeds were planted, the plants will be ready to be set out in the field. They should then be about 60 to 80 cm. tall and should be accustomed to full sunlight. The latter is accomplished by gradually removing the shade from the nursery until the plants are sufficiently hardened to withstand full sunlight.

When working with *C. pubescens* seedlings which are not so delicate, all seedlings may be allowed to remain in the original seed-bed until they attain a height of 10 to 15 cm. at which time they may be transferred to the nursery (without waterproof cover) at a distance of 15x15 cm. Here they gradually are accustomed to full sunlight and when they attain a height of 25 to 30 cm. the rows are thinned out so as to establish distances between plants that are convenient for grafting. This is done by taking up and transplanting to another place every other row and every other plant in the row. A good planting arrangement for grafting purposes consists of units of 4 rows 30 cm.

apart between rows and 30 cm. between plants, and walks of 60 cm. between each unit of 4 rows. This can be obtained both in the thinned out original planting and in a new planting made with the removed plants. With this arrangement two rows of each unit of 4 may conveniently be grafted from the 60 cm. walks.

*Permanent Field Plantings.* — The matter of planting distance and the size of holes to be dug in advance of planting depends largely on the region where the planting is to be located and on the land economy prevalent there. In Java, they have evolved the practice of planting the trees very close to each other with the intention of beginning to thin out the plantation about four years after the plants have been set out and continuing with a yearly thinning out or pruning of the plantation until it is ten to fifteen years old, at which time all of the remaining trees are pulled out, roots and all, to make the final harvest. The trees are usually set out on a square or quincunce pattern with 1 m. to 1.5 distance between them. It would seem a good plan to follow this practice for the time being.

Until experimentation may demonstrate a more suitable size, it would seem satisfactory to dig holes 30x30x30 cm. The holes should be dug several months in advance of planting.

*Disease Control Measures.* — For the most part, the diseases that affect *Cinchona* are soil borne fungus diseases caused by fungus species of such genera as: *Nectria, Fusarium, Rosellinia, Pythium, Rhizoctonia,* etc. These manifest themselves in the seedbed as damping-off and in the nurseries and the permanent plantings, as canker and wilt disease. We do not know of an efficacious manner of combatting them other than the avoidance of damping-off in the seed-beds by careful water and shade control; the exercise of cleanliness in all seed bed and nursery practices; and the setting out of only healthy, strong, vigorous plants. The drying out and sunning of seed-bed and nursery-bed soil in advance of planting is helpful in avoiding fungus diseases in these two places. The digging of holes in advance in the field plantings may also be beneficial in this way. The use of Bordeaux mixture in the nurseries and seed-beds may be of some slight help, but certainly the avoidance of disease is much to be preferred. The avoidance of old coffee lands is recommended.

*Grafting.* — As a general rule, *Cinchona* plants of high quinine content are delicate, slow growing plants with weak root systems, subject to disease. Except in virgin soil rich in humus, great difficulty is usually had in establishing plantings with this type of tree as seedlings on their own roots. Much more vigorous plants are obtained when scions (yema o vastago que se injerta) of this type are grafted on succirubra stocks.

The succirubra stocks are best grafted when they are about 60 to 80 cm. tall and their trunks are about as thick as a lead pencil or somewhat thicker. A *side graft* using a scion having two nodes and at least two plump healthy side buds is recommended for *Cinchona* grafting (*see* BAILEY's *Encyclopedia of Horticulture* for discussion of *side graft*). The best scion material is obtained from twigs having about the thickness of a pencil or slightly less with short internodes and taken from a section near to the terminal shoot of the branch. It is preferable that the base of the scion should have a bark brown in color and that the top of the scion should have green bark. It is preferable to attach the scion to the stock about 15 cm. above soil level (this later leads to the incidence of bothersome side sprouts from the stock plant, but is otherwise highly desirable because there is less danger of the scion material becoming infected with fungus collar-rot typical in some so-called "wilt" diseases of *Cinchona*).

The grafts are best wrapped with grafting tape and then thoroughly waxed over with paraffin. From 20 to 30 days after the grafting operation (depending on temperature of locale) the wrappings may be cut away and the terminal shoot of the stock cut off. About a month later, the stock should be pruned leaving two pairs of leaves above the scion, and a month after that the stock may be cut off about 5 cm. above the graft union. When the grafted plants are dug up for transplanting to their permanent location in the field, the stock may be cut off flush just above the graft union. A grafted plant is large enough for setting out in the field in about 8 to 10 months after the grafting operation.

BOARD OF ECONOMIC WARFARE,
WASHINGTON, D. C.

ERNEST GUENTHER: **The Production of Essential Oils in Latin America:** — Essential oils are composed of complicated mixtures of terpene derivatives which make plants, or parts of plants, fragrant. Essential oils are also called volatile oils because, unlike fatty oils (coconut, linseed, sesame, etc.), they volatilize at ordinary temperature. In fact, the odor of essential oils is a function of their volatility.

The term "essential" which originates from the French "essence" is quite appropriate insofar as these oils are important constituents in many necessities of our daily lives. Each day we utilize a great variety of essential oils in pharmaceutical and semi-pharmaceutical preparations, foods, such as meats, sausages, canned goods, table sauces, bakery products, furthermore in hard candies, confectionery, chewing gums, beverages (alcoholic and non-alcoholic), soaps, disinfectants, room sprays, cosmetic and toilet articles, perfumes, and many others. The figures of the essential oil trade itself may not appear very impressive, but the fact remains that many industries depend upon essential oils for odor and flavor of their products, not to speak of the medicinally active principles. The soap and cosmetic industries alone show a yearly turnover of several hundred million dollars, which sum must be largely increased if we include the vital pharmaceutical, food and beverage industries Hundreds of thousands, if not millions, of people depend for their livelihood upon the manufacturing, advertising, wholesale and retail distributing of these goods, most of them necessities, a few luxuries.

Essential oils are the products of plant physiological processes. It is not clear yet whether they form part of the reactions involved in the assimilation of carbon dioxide and the building of plant tissues, or whether they are connected with other processes, for instance, the elimination of waste matter, attraction of bees for fecundation or defense against insects and pests. Much work has been done toward solving this problem, but the results are not yet sufficiently clear to give preference to one or the other theory.

Essential oils originate in intracellular glands or sacs, and in hair-like structures. Various parts of a single plant may produce oils of quite different physico-chemical properties and chemical composition. The sour or bitter orange tree, *Citrus aurantium* L., offers the best example; the leaves and twiglets contain the so-called oil of petitgrain, the blossoms oil of neroli bigarade, while the peel of the fruit contains again a different oil.

*Production of Essential Oils.* — The production of essential oils must be carried out according to the condition in which the oil occurs in the plants. If the oil is present ready-formed and in large amounts, it can be extracted by the simple method of pressing. In a primitive way it may be carried out by handpressing, while in technically advanced countries machines are employed.

In most instances, the essential oil occurs in the plants in such minute amounts that mere pressing gives no results. In this case the oils are obtained by distillation. The principles of distillation are simple. The plant material is charged into a still; water is added and brought to a boil, or live steam, generated in a separate boiler, is injected. The steam softens or ruptures the walls of the oil glands, liberates the oil and carries it over as vapor into the condenser where steam and oil vapors are reliquefied by cooling, and collected in an automatic separator, the so-called Florentine flask. Not being soluble or miscible, the two layers of oil and water flow off separately. Today the bulk of essential oils is produced by distillation. In many instances, it is carried out in rather primitive portable stills set up in regions favored by an ample supply of plants. Distillation is also undertaken in the large and modern factories of Europe and the United States which process plant material grown nearby, or domestically, or imported from abroad.

The entire production of essential oils can thus be classified according to two principles:

(1) In most instances the aromatic plants grow wild or are cultivated as garden or patch crops by natives. Raising the plants and distilling the oil represents a family industry, often a side occupation, based upon cheap labor, without cost calculation. The natives produce small quantities of one or two oils according to primitive methods and sell them through field brokers to village buyers until the oils finally reach the exporters in the shipping ports. The price of these oils depends upon the market which, in turn, is influenced by supply and demand. The natives are usually well aware of the prevailing quotations and prefer to stock up their output rather than sell it at unattractive prices. Modern methods of production can hardly compete with this primitive industry because the natives never consider their own and their families' labor.

(2) Advanced processing methods, based upon modern agriculture and engineering, try to compete with low priced labor by mass production. The oils obtained in these essential oil factories are of superior quality but the operating expenses are usually high; many factors, such as, a higher standard of living and wages, salaries of directors, taxes and general overhead, increase the cost of production. A modern factory of that type, trying to specialize in the production of one yearly crop can hardly survive under these conditions; operation is profitable only if a variety of plants can be processed, thus keeping the enterprise busy all year around, or at least most of the year. Such an organization would have to produce several oils from plants grown mainly in the vicinity. In other words, a factory of this type should be located near large plantations connected with good roads, and would require conditions of soil, climate and altitude which permit the growth of varied crops of aromatic plants. Theoretically, this is the ideal solution for our industry, but it involves heavy initial expenses, and a great deal of agricultural research work before the proper location can be found, and the proper crops selected and grown.

Today, most essential oils are produced on the basis of a primitive family industry flourishing in many corners of far-off countries and only in a few instances have we succeeded in placing production on a modern agricultural and technical basis. Today, California and Florida produce very large quantities of excellent citrus oils because these states possess a network of good roads and railroads permitting trucking or hauling of the fruit from distant orchards and sections to centrally located modern processing plants. Because of this fact the United States became independent in regard to oil of lemon and oil of orange. In the course of years, a corresponding evolution will probably take place also with other oils which so far have been produced in far-off corners of more primitive countries.

Thanks to extensive field research work carried out abroad the American essential oil industry, before the outbreak of the present war, had reached a high degree of perfection, even though most oils still were imported from abroad where the old methods prevailed. The outbreak of World War II abruptly changed this picture. This applies not only to essential oils but to spices and drug plants in general. In many ways, the essential oil, the spice and crude drug industries are intricately interwoven, many essential oils being distilled in America and Europe from imported spices, plants and drugs.

Today, the Americas are cut off from most of the former sources, especially those in Central Europe and in the Far East. Therefore, our pharmaceutical, food, beverage, soap, cosmetic and perfume industries are no longer in a position to manufacture some of their world-famed specialties unless new sources of the basic materials, especially essential oils, can be established in the Western Hemisphere. Many attempts are being made to this effect, fostered by Government agencies, for instance, the Department of Agriculture-Office of Foreign Agricultural Relations, Pan American Union Inter-American Institute of Agricultural Science, the Coordinator of Inter-American Affairs Agricultural Division, and others, not to mention a few private firms who possess the actual experience and knowledge for producing and handling these valuable ingredients. The task is made difficult by its specialized character and by the scarcity of experts actually trained in essential oil production. Many factors have to be considered, such as, conditions of climate, soil and altitude, experience in planting, growing and distilling. Much of the planting material is, at present, unavailable. However, despite all these difficulties, a slow but steady progress is being made. It is quite possible that the present emergency will force the Western Hemisphere into the establishing of its own essential oil, spice and crude drug production. Until a few years ago, this task would have been impossible because it was hopeless to compete with the low priced labor of Africa, Japan, China, India, and the Dutch East Indies. With the present high market prices and the increasing scarcity of oils, the task seems easier. The

United States Government is now willing to advance capital to serious prospective growers south of the border whereas, in years past, it was very difficult to obtain private funds for tiding over the first years of costly experiments. Many of the oils will have to be produced in Central and South America because of their tropical climate, and because of the lower labor cost prevailing there. This need is becoming increasingly urgent because our armed forces and our Allies abroad depend upon us for supplying food which is palatable. No army can march without food and food must be palatable. In this group fall the so-called spice and condiment oils. Some of these plants require a temperate climate and there should be no insurmountable difficulties in producing them at reasonable and competitive prices in the more temperate zones or higher altitudes of Latin America.

Hardly a day passes that the writer does not receive letters from Central and South America requesting information and assistance in the task of growing aromatic plants and producing essential oils. Many of these new ventures will prove futile because of adverse natural conditions, but some will be and already are successful. The task will become easier as more experience is gathered and as the various Government agencies and experiment stations exchange their findings and cooperate with the practical-minded and experienced North American essential oil houses. It would not be surprising if, after the present hostilities have ended, the Western Hemisphere should find itself to a certain degree independent of the rest of the world, at least in regard to some of the most vital essential oils, spices and crude drugs.

*Actual Production of Essential Oils in Latin America.* — The following will give a short account of those oils which are actually being produced in Central and South America, including the West Indies, and of those which are still in the experimental stage.

— WEST INDIES —

*Cuba.* — Not much is being done at present in regard to essential oils despite inquiries on the part of prospective growers, probably for the reason that Cuba is accustomed mainly to the production of sugar.

*Jamaica.* — This island produces limited quantities of oil of lime (*Citrus aurantifolia* Swingle), sweet orange (*Citrus sinensis* [L.] Osbeck), and pimenta (*Pimenta officinalis*).

The pimenta tree is cultivated and also grows semi-wild in several parts of the island. The dried berries ("Allspice") are exported as such to the United States and England for the flavoring of food products and for distillation purposes. On the island the pimenta leaves too are distilled. The leaf oil though not quite as fine as the berry oil, is also used for flavoring meats, sausages, table sauces, canned goods and so forth. For a long time Jamaica has been producing a very high grade of ginger root which is considered superior to the African and Cochin kind.

*Haiti.* — The Société Haitiano-Americaine de Développement Agricole, Port-au-Prince, financed by the American Government, is devoted primarily to the growing of the rubber tree, but has also started to develop aromatic plants, particularly lemongrass (*Cymbopogon citratus*) and ginger root (*Zingiber officinale*). Similar projects are being undertaken by a few private growers in Haiti.

Oil of lemongrass is one of the most important essential oils, produced in large quantities along the Cochin Coast of Southern India. It finds wide application for the scenting of soaps and in all kinds of technical products. The oil serves, furthermore, for the isolation of citral, a valuable flavoring constituent with a lemon-like odor. Citral is a starting material also for the manufacturing of the so-called ionones which possess a typical violet odor and are employed very extensively in perfumes, cosmetics and for the scenting of soaps.

The sour or bitter orange (*Citrus aurantium*) grows wild and semi-wild in certain parts of Haiti. From the leaves, the so-called oil of petitgrain bigarade is distilled, and from the fresh blossoms, the valuable oil of neroli bigarade. Both oils came formerly from France.

Haiti, furthermore, produces small quantities of lime oil and is now experimenting with oil of vetiver (*Vetiveria zizanioides*), the plant growing there semi-wild.

*Dominican Republic.* — Along the Bay of Sosua, a colony of Jewish refugees from Central Europe, aside from their main agricultural activities, are trying to raise lemongrass.

*Puerto Rico.* — The Experiment Station of the United States Department of Agriculture in Mayaguez, one of the most prominent institutes of tropical research, has done outstanding work in the development of essential oils.

Puerto Rico produces considerable quantities of oil bay (*Pimenta acris*). The oil is distilled from the leaves and serves in toilet preparations, especially bay rums, also for the flavoring of food.

Puerto Rico furthermore produces limited quantities of sweet and bitter orange peel oil.

*Virgin Islands.* — Also producers of bay oil.

*Dominica.* — This British possession has for many years been one of the heaviest producers of oil of lime, distilled and coldpressed. The oil is employed very extensively for the flavoring of confectionery, candies, especially of soft drinks.

Dominica furthermore produces oil of bay.

Other projects with aromatic plants, for instance, ginger, cinnamon and citronella are on the way.

*Trinidad and Tobago.* — These British islands have always been large producers of oil of lime, distilled and coldpressed.

— CENTRAL AMERICA —

*Mexico.* — The lime tree (*Citrus aurantifolia*) grows wild and semi-wild in the state of Vera Cruz; it is planted extensively on the west coast near Acapulco and Colima, and in other sections. Today Mexico has become a very heavy supplier of oil of lime, distilled and coldpressed.

Mexico also produces oil of linaloe in the state of Puebla and in Eastern Guerrero. The tree (several species of the *Burseraceae*, particularly *Bursera aloexylon*) grows wild and must be felled for distillation of the wood. Oil of linaloe is employed in perfumes, cosmetics and for the scenting of soaps.

A number of projects on the cultivation of aromatic plants are underway in the highlands, for instance, Japanese mint (*Mentha arvensis*), coriander (*Coriandrum sativum*), anise (*Pimpinella anisum*), cumin (*Cuminum cyminum*), and a few others. *Eucalyptus globulus* grows wild and semi-wild in the vicinity of Mexico City. With its great variety of climate and altitude, Mexico offers many possibilities for the production of essential oils, provided the projects are well organized, properly financed and based upon agricultural research work.

The region around Fortin near Vera Cruz seems favorable to the starting of a natural flower oil industry, provided the Indian growers can be taught to raise flowers not only for their appearance (cut flowers), but also for a maximum content of essential oil. This will require much educational work and the investment of considerable capital in factory equipment for the extraction of the flowers with volatile solvents.

*Guatemala.* — This small republic is a country par excellence for the growing of aromatic plants and the distillation of their oil as the country is favored by low priced labor and a great variety of climate, soil and altitude. Along the Pacific Coast, Guatemala is today producing large quantities of oil of lemongrass and citronella which were formerly imported exclusively from East India and Dutch Malaya. These plantings could undoubtedly be extended considerably.

Guatemala is, furthermore, experimenting with other aromatic plants, such as coriander, ginger, palmarosa, *Mentha arvensis*, and so forth. *Eucalyptus citriodora*

and the camphor tree (*Cinnamomum camphora*) are being planted now on the outskirts of Guatemala City.

*Salvador.* — Salvador has for a long time been a producer of the so-called balsam Peru. This balsam is a pathological exudation of the tree *Myroxylon pereirae* which grows wild in the so-called balsam coast of Salvador. The balsam finds extensive application in pharmaceutical preparations, also in perfumes and especially for the scenting of soaps.

*Honduras.* — This republic too has lately started to grow lemongrass and citronella. For many years Honduras has been a producer of gum styrax. Styrax is a pathological exudation of the styrax tree (*Liquidambar styraciflua*) which grows wild in the jungles of Honduras. The balsam is employed in perfumes, cosmetics and especially in the scenting of soaps, furthermore in certain pharmaceutical preparations.

The coastal regions of Honduras, with their warm and humid tropical climate, seem to offer good possibilities for the growing of spices such as clove, nutmeg, cinnamon, pepper, cardamom and ginger.

*Nicaragua, Costa Rica and Panama.* — Little has been done in regard to actual production of essential oils, but the new Inter-American Institute of Agricultural Science in Turrialba, Costa Rica, offers excellent opportunities for research work along these lines.

— SOUTH AMERICA —

*Venezuela.* — Not much has been accomplished in regard to essential oils.

*Colombia.* — Colombia has for a long time been a producer of balsam Tolu, a pathological exudation of the tree *Myroxylon balsamum*. This product is used in perfumes, cosmetics, also for the scenting of soaps and in some pharmaceutical preparations.

*Eucalyptus*, particularly *E. globulus*, grows wild and semi-wild in the vicinity of Bogotá, very limited quantities of oil being distilled from the leaves.

*Ecuador.* — Small quantities of ambrette seed (*Hibiscus abelmoschus*) have been grown in that country and shipped to North America and Europe for distillation.

*Peru and Bolivia.* — Not much has been done on the development of essential oils.

*Chile.* — Because of the variety of climate and altitude Chile should be in an excellent position to produce aromatic plants and essential oils. Offers of aromatic plants have frequently been made in the United States, but not much has been heard regarding essential oils.

*Argentine.*—Here, too, the possibilities for the development of a domestic essential oil industry are excellent. Argentine, especially in the elevated region around Mendoza, has started to produce oil of peppermint, oil of lavender, and all kinds of aromatic plants, for instance, chamomile, from which the oils could be distilled.

*Uruguay.* — Nothing known to the writer in regard to essential oils.

*Paraguay.* — For many years Paraguay has been the principal producer of the so-called oil of petitgrain. It is distilled from the leaves of the sour or bitter orange (*Citrus aurantium*), which grows wild, semi-wild and cultivated over wide stretches of Paraguay's interior. Oil of petitgrain is used extensively in perfumes, cosmetics and especially for the scenting of soaps.

Paraguay is the principal source of supply for oil of guaiac wood which is distilled from the fragrant wood of *Bulnesia sarmienti* which tree grows wild in the interior, especially in the Gran Chaco. Because of its rose-like odor, this oil serves in perfumes, cosmetics, and for the scenting of soaps.

*Brazil.* — For a long time Brazil has been a producer of several essential oils; that vast country offers many possibilities for new developments.

The copaiba tree (several species of *Copaifera*) growing wild in the middle and lower Amazon basin yields a balsam which is employed widely for the scenting of soaps and also in pharmaceutical preparations.

The fragrant rosewood tree (*Aniba rosaeodora* var. *amazonica*) occurs wild in the more elevated altitudes along the tributaries of the right bank of the Amazon River, in the states of Amazonas and Pará. The wood yields upon distillation an essential oil which is employed in perfumes, cosmetics and for the scenting of soaps. An important oil, serving also for the isolation of linalool.

For the past few years the state of Santa Catarina has been producing large quantities of the so-called Brazilian sassafras oil, distilled from the wood of *Ocotea pretiosa*, a beautiful tree growing wild and abundantly between Rio do Sul and Blumenau.

The state of São Paulo has for some years been producing several citrus oils, particularly sweet orange oil; in fact, large stocks of the latter oil have accumulated, and the possibilities for future expansion are great.

For the last two years, considerable quantities of Japanese mint oil (*Mentha arvensis*) have been distilled in the state of São Paulo, especially around Presidente Prudente. If the contemplated extension of the plantations is realized and not hampered by plant diseases or insect pests, Brazil may well replace Japan as a source of supply for this important oil, the best starting material for the isolation of natural menthol. This far reaching project represents one of the most amazing developments in the whole Western Hemisphere.

São Paulo is also experimenting with and already producing oil of lemongrass, citronella, vetiver, patchouly, geranium, and especially oil of *Eucalyptus citriodora*. Indeed, production of the latter oil could at any time be increased considerably, as the tree grows quickly.

*Prospective Essential Oils for Latin America.* — The following table does not pretend to list all commercially important essential oils, but only those which from the practical point of view should or could be considered for production in Latin America.

OIL OF ANGELICA, distilled from the dried root and from the seed of *Archangelica officinalis*. The oil was formerly imported from Belgium, France and Germany. Limited quantities are employed in flavors, especially in cordials and gins, also in perfumes.

OIL OF ANISE, distilled from the dried ripe seed (fruit) of *Pimpinella anisum*. The oil was formerly imported from Central Europe and from Russia. It is employed for flavor work, particularly in confectionery, instead of the condiment, also in semi-pharmaceuticals, oral preparations for instance.

OIL OF SWEET BASIL, distilled from the flowering tops of *Ocimum basilicum*. Formerly imported from Southern France and used in limited quantities for flavoring purposes, also in perfumes.

OIL OF BERGAMOT, obtained by expression from the rind of the fresh fruit of *Citrus aurantium* L. subsp. *bergamia* (Risso & Poit.) Wight & Arn. One of the most important essential oils of general application, cultivated extensively and exclusively in Calabria, Southern Italy. The establishment of a new bergamot industry in the Western Hemisphere seems worthwhile, although the growing of the tree would require several years.

OIL OF CAJUPUT, distilled from the fresh leaves of several varieties of *Melaleuca leucadendron*. The oil is used mainly for pharmaceutical and technical preparations. Formerly it was imported from the island of Boeroe in the Dutch East Indies where it is produced exclusively.

OIL OF CALAMUS, distilled from the dried root of *Acorus calamus*. Imported formerly from Northern France, Belgium, other parts of Central Europe and Russia, also from Japan. The oil is used rather extensively for the flavoring of food products and liqueurs, also in perfumes.

OIL OF CANANGA, distilled from the fresh flowers of a variety of *Canangium odoratum*. Formerly imported from the island of Java. The oil finds application in perfumes and soaps. Production in the Western Hemisphere should be considered but the growing of the trees will take years.

OIL OF CARAWAY distilled from the dried ripe seed of *Carum carvi*. Produced in Europe, especially in Holland and Russia, the oil is now scarce on the American market. Widely employed, instead of the condiment, for the flavoring of meats, sauces, confectionery, baked goods and curries, also in liqueurs, furthermore in pharmaceuticals.

OIL OF CARDAMOM, distilled from the dried, ripe seed of *Elettaria cardamomum*. The spice is grown in Ceylon and along the Malabar Coast of Southern India, but now hard to obtain on account of shipping difficulties. The oil, usually distilled in the United States or Europe from imported seed, is employed for the flavoring of food products, especially confectionery.

OIL OF CARROT, distilled from the seed of *Daucus carota*. Very small quantities which formerly were imported from Central Europe are employed in liqueurs and in perfumes.

OIL OF CASSIA, distilled from the leaves, twigs and bark of *Cinnamomum cassia*. Produced in the provinces of Kwangsi and Kwangtung, Southern China, the oil is no longer available. Large quantities are required for the flavoring of all kinds of food products, confectionery, candies, chewing gums, sauces, soft drinks and in pharmaceuticals and semi-pharmaceuticals. A new source of supply in the Western Hemisphere is highly desirable, although the growing of the tree would require several years.

OIL OF CELERY, distilled from the dried, ripe seed of *Apium graveolens*. Imported formerly from Southern France, the French oil has become unavailable on the American market, but Indian seed is still being imported. A new source of supply in the Western Hemisphere is desirable. The oil finds wide employment, instead of the condiment, for flavoring purposes, in celery tonics and in many food products.

OIL OF CHAMOMILE, GERMAN, distilled from the dried flowers of *Matricaria chamomilla*. Produced in Germany and Hungary and no longer available. Very limited quantities are employed for flavoring purposes, in semi-pharmaceuticals and in perfumes.

OIL OF CHAMOMILE, ROMAN, distilled from the dried flowers of *Anthemis nobilis*. Formerly imported from Western and Southern Europe. The oil finds the same application as that of the German chamomile.

OIL OF CINNAMON, distilled from the aromatic, dried inner bark of true *Cinnamomum zeylanicum*. The bush or tree is grown in French Indo-China, the Seychelle Islands, Madagascar, and especially on the island of Ceylon. Supplies of the bark are now scarce. The oil, distilled mainly in Europe or America from the imported spice, finds wide application for high class flavor work, especially in confectionery, beverages, also in perfumes.

OIL OF CITRONELLA, distilled from the grass of *Cymbopogon winterianus*. One of the most important essential oils, large quantities of which were formerly imported from Java. The oil is widely employed for the scenting of soaps and in all kinds of technical preparations, including insecticides. Important also as starting material for the making of synthetic menthol. New sources of supply in the Western Hemisphere are highly desirable.

OIL OF CLOVE, distilled from the dried flower buds of *Eugenia caryophyllata*. The spice is still being produced in Zanzibar and Madagascar but shipping difficulties make it scarce in the United States. The oil is usually distilled in Europe or North America from the imported spice. The establishment of a new clove industry in the Western Hemisphere seems desirable, although the growing of the tree requires many years. The oil is widely used for the flavoring of all kinds of food products, especially meats, table sauces, confectionery, also for the scenting of soaps, furthermore in many pharmaceuticals and semi-pharmaceuticals as a powerful disinfectant. It is the starting material for the isolation of eugenol employed in perfumes and cosmetics, and as an antiseptic.

OIL OF CORIANDER, distilled from the dried, ripe fruit of *Coriandrum sativum*. Produced in Central Europe and especially in Russia, the oil is now scarce on the American market. Employed mainly in flavors, to a limited extent also in perfumes.

OIL OF CUBEB, distilled from the berries of *Piper cubeba*. Formerly imported from Java and other islands of the Dutch East Indies, cubeb berries are now almost unobtainable on the American market. The oil which is distilled from imported berries finds application for the flavoring of many food products, especially table sauces.

OIL OF CUMIN, distilled from dried, ripe seed of *Cuminum cyminum* which is grown in Asia Minor, Morocco, British East India and Central America. The oil replaces the seed for the flavoring of many food products, especially curries.

OIL OF ESTRAGON, distilled from the flowering herb of *Artemisia dracunculus*. The oil was formerly imported from Southern France. Small quantities are employed for the flavoring of sauces and vinegars.

OIL OF EUCALYPTUS, distilled from the leaves of several *Eucalyptus* species. Large quantities of the oil are produced in Australia, but present shipping and war conditions make it advisable that the oil be produced also in the Western Hemisphere. Oil of eucalyptus is very widely employed in medicinal preparations, particularly in mouth washes, dental preparations, inhalants, room sprays and medicated soaps, also in cough drops, etc. Large quantities of the oil are used in floating processes.

OIL OF FENNEL, distilled from the ripe, dried seed of *Foeniculum vulgare* which is grown in Central Europe and Russia. The oil now being scarce in the Western Hemisphere, production there should be considered. Employed mainly for flavoring all kinds of food products, particularly confectioneries, furthermore in pharmaceutical and semi-pharmaceutical preparations.

OIL OF GERANIUM, distilled from *Pelargonium graveolens* on Réunion Island (South Indian Ocean) and in Algeria. At present scarce on the American market, although widely used in perfumes and especially in soaps.

OIL OF GINGER, distilled from the dried rhizomes of *Zingiber officinale* which is grown in West Africa, on the Malabar Coast in Southern India, and on the island of Jamaica. The root has become scarce on the American market, although it is widely used in confectioneries. The oil finds wide application in soft drinks, in confectionery goods and for the flavoring of many food products. Since the growing of the root offers no difficulties, production in the Western Hemisphere should be extended.

OIL OF HYSSOP, distilled from the flowering tops of *Hyssopus officinalis*. The oil was formerly imported from Southern France, Germany and Hungary, but is no longer available. Very small quantities are employed in flavor work, particularly in cordials.

OIL OF JUNIPER, distilled from the dried, ripe fruit of *Juniperus communis*. Formerly imported from Northern Italy, Tyrol, Czechoslovakia, Hungary and Yugoslavia, the oil is no longer available, although it plays an important role in the flavoring of many food products and beverages, especially in gin. Production in the Western Hemisphere seems difficult as true *Juniperus communis* L. grows wild in Central Europe and is not planted. There exists a strong demand for this oil but most American varieties of juniper offered on the market are inferior to the imported berries.

OIL OF LAUREL, distilled from the leaves of the tree *Laurus nobilis*. Formerly imported from Dalmatia, the oil is used mainly in culinary preparations, but only in small quantities.

OIL OF LAVANDIN, distilled from the flowering lavandin plant, a hybrid between true lavender (*Lavandula vera*) and spike-lavender (*Lavandula latifolia*). Imported formerly in large quantities from Southern France. Widely employed in the scenting of soaps.

OIL OF LAVENDER, distilled from the flowering tops of *Lavandula vera*. A very important essential oil, formerly shipped in large quantities from Southern France, it is no longer available in America. Lavender oil finds application for the scenting of soaps, in toilet waters and perfumes. It should not be too difficult to produce this oil in temperate zones and higher altitudes of Latin America, although the raising of the plants will require at least two years.

OIL OF LIME, distilled from the juice of the crushed fruit of *Citrus aurantifolia*, in the West Indies and Mexico. The present production merits still further expansion in Central and South America. Very extensively used for the flavoring of confectionery, hard candies and especially soft drinks.

OIL OF MACE, see oil of nutmeg.

OIL OF MARJORAM, distilled from the flowering *Origanum majorana*. Formerly imported from Southern France, North Africa and Hungary. Employed in flavor work, especially in meats, sausages and table sauces.

Oil of myrtle, distilled from the leaves and twiglets of *Myrtus communis.* Formerly imported from Southern France, Corsica, Morocco and Algeria. Limited quantities are used in flavors and toilet waters.

Oil of neroli bigarade, distilled from the fresh blossoms of the sour or bitter orange (*Citrus aurantium*). Substantial quantities of this expensive oil were formerly imported from Southern France, Sicily and Algeria. Production in the Western Hemisphere could be considered wherever the bitter orange tree grows. Employed in high class perfumes and eaux de cologne.

Oil of nutmeg, distilled from the dry kernel seed of *Myristica fragrans.* The bulk of the spice was formerly imported from Malaya, but is no longer available despite a great demand on the part of our food and flavoring industries. The oil is distilled from the imported spice and, therefore, extension of the present limited production of nutmeg in the West Indies to other Latin American countries is highly desirable.

Oil of origanum, distilled from the flowering *Coridothymus capitatus.* The present main producing regions are in Southern Spain and Morocco where the plant grows wild, but the quantities reaching the American market are small. Employed as an antiseptic in many pharmaceuticals and semi-pharmaceuticals, especially oral preparations, furthermore for the scenting of soaps.

Oil of orris root, distilled from the dried root of *Iris florentina.* The principal growing regions are in the Apennines Mountains around Florence, Italy. The oil was formerly distilled in Southern France from Italian root, but is no longer available despite a keen demand on the part of our perfume and cosmetic industries. The growing of the root in Latin America should be encouraged.

Oil of palmarosa, distilled from the grass *Cymbopogon martini* var. *motia.* Produced in the British East Indies, but shipments to America rather scarce. The oil could be produced from the quick growing grass in many Latin American countries. Employed for the scenting of soaps, also in perfumes and cosmetics.

Oil of parsley, distilled from the dried, ripe seed and from the seeding herb of *Apium petroselinum.* Formerly limited quantities of this oil were imported from France. Very useful for the flavoring of all kinds of food products, especially meats, sausages and table sauces.

Oil of patchouly, distilled from the dried leaves of *Pogostemon cablin* Benth. (*P. patchouli* Pell.). Produced exclusively in British Malaya and on the island of Sumatra, both sources of supply being no longer available to America. The oil finds wide application in all kinds of perfumes, cosmetics and soaps. Production in the tropical part of Latin American countries is highly recommended, especially in view of the fact that the plant can be grown rather quickly.

Oil of pennyroyal distilled from *Mentha pulegium,* which grows wild in Southern Spain and Morocco. Because of war conditions, the oil is not as easily available in the United States as formerly. Employed for the scenting of soaps and also as a convenient starting material for the manufacturing of synthetic menthol.

Oil of pepper, distilled from the dried, ripe fruit of *Piper nigrum.* The spice is produced exclusively in Malaya, the southern part of British East India, French Indo-China and Madagascar. Most of the former sources of supply are no longer accessible and, therefore, a decided shortage of pepper might result in the Western Hemisphere within a few years. The growing of the pepper tree in the tropical part of Latin America is, therefore, highly desirable, although a few years are required until the first harvest of pepper can be reaped.

Oil of (pepper)mint, Japanese, distilled from *Mentha arvensis* var. *piperascens.* This important oil is produced almost exclusively in Japan, but is no longer available. It remains the most important raw material for the isolation of natural menthol. Therefore, the growing of *Mentha arvensis* in the more temperate zones of Latin America is highly recommended. Menthol finds wide application in pharmaceutical and semi-pharmaceutical preparations and is officially considered a vital material.

Oil of rose, distilled from the fresh flowers of *Rosa damascena.* Formerly imported almost exclusively from Bulgaria, but no longer available. Our perfume and cosmetic industry is keenly interested in this most valuable oil.

Oil of rosemary, distilled from the flowering tops of *Rosmarinus officinalis.* Formerly imported in large quantities from Spain and also from Tunisia, the oil has become scarce on the American market. Large quantities employed in technical preparations, for the denaturing of alcohol, and especially for the scenting of soaps. Although the plant grows wild in Spain, it could also be planted in certain sections of Latin America.

Oil of sage clary (muscatel), distilled from the flowering herb of *Salvia sclarea.* Formerly imported from Southern France and from Southern Russia. The oil could also be produced in the temperate zones of Latin America. It is employed in perfumes and cosmetics.

Oil of sage, distilled from the leaves of *Salvia officinalis.* Previous to the war considerable quantities of this oil used to be imported from Dalmatia where the plant grows wild. Widely employed for the flavoring of all kinds of food products, especially meats and sausages. The production of this oil in the temperate zones of Latin America is highly desirable, but care should be taken to start plantings only from true *Salvia officinalis* and not from one of the many local varieties which possess an entirely different odor and flavor.

Oil of savory, distilled from *Satureja hortensis.* Formerly imported from Central and Southern Europe in small quantities. Employed in flavor work, particularly for culinary preparations.

Oil of spike lavender, distilled from *Lavandula latifolia.* Large quantities have annually been imported from Spain where the plant grows wild. The oil is employed widely for the scenting of soaps. There is a possibility that the plant could also be cultivated in temperate zones of Latin America.

Oil of thyme, distilled from *Thymus vulgaris.* Substantial quantities have been imported from Spain and Morocco. A powerful antiseptic employed widely in oral and dental preparations, inhalants, room sprays, soaps. The oil is also used in flavor work, particularly for culinary purposes, meats, sausages and so forth. The plant grows wild in Spain and Morocco, but could also be cultivated in the more temperate parts of Latin America.

Oil of valerian, distilled from the dried root of *Valeriana officinalis.* Formerly imported from Belgium, France, Germany, and Japan. The oil as well as the dried root have become very scarce on the American market. Small quantities of the oil are employed for flavoring and also in pharmaceutical preparations.

Oil of vetiver, distilled from the dried root of *Vetiveria zizanioides.* Imported formerly in considerable quantities from Java and also from Réunion Island, the oil has now become scarce on the American market. Employed widely in perfumes, cosmetics and in soaps. Plantings have been started in several parts of Latin America, but their extension is desirable.

Oil of ylang ylang, distilled from the flowers of a variety of *Canangium odoratum.* Produced in Madagascar, the Comoro Islands, Réunion Island and the Philippines, and imported formerly in considerable quantities, the oil is now rather scarce on account of shipping difficulties. The planting of trees in coastal tropical parts of Latin America might be desirable, although the growing of the trees will require several years.

*Importance of Research Work.* — Undoubtedly many years will pass before the Western Hemisphere can become independent in regard to essential oils, but the present emergency provides a powerful stimulant in this respect.

However, before starting any new venture along these lines, a prospective grower should look carefully into the market outlet for any essential oil he intends to produce. It must not be forgotten that the use of essential oils is limited, in many cases very limited indeed, and even the lowering of prices will not stimulate the demand and increase the consumption. Even the slightest over-production will automatically and almost immediately result in a

discouraging, often ruinous decline of the prices. It should be also kept in mind that most essential oils are perishable goods which can be stored only for a limited number of years after which their quality gradually deteriorates.

Two factors, therefore, are of utmost importance.

*1.* Scientific and practical agricultural research, studies on the selection of high yielding varieties, investigations on the conditions of soil, climate, weather and insect pests must precede the laying out of actual plantings. Aside from articles published in a number of trade papers by a few leading authorities, there exists at present surprisingly little up-to-date literature on the subject. The few textbooks, some of them out of print, some obsolete, deal mainly with the chemistry and analysis of essential oil but not with the agricultural aspect.

*2.* The first experimental lots of oil distilled in a small pilot plant should be submitted to a competent and reliable essential oil house in the United States so that the grower can be guided technically and advised as to the quality of his new products and their adaptability to the actual market demands. All too frequently producers spend a great deal of time and money on the growing of some aromatic plants and the distillation of oils which they hope might possess some value until an expert reports that the new oil is interesting from the scientific point of view, but has absolutely no established market, and little chance of ever being adopted. The leading essential oil houses in New York are intimately familiar with the market demands of our industries and thereby in an excellent position to save the prospective growers in Latin America a great deal of time and money, in other words, to assist them from the practical point of view.

FRITZSCHE BROTHERS, INC.,
NEW YORK CITY.

K. S. MARKLEY: **Fat and Oil Resources of Latin America:** — The Latin American Republics taken as a whole possess one of the greatest actual and potential sources of vegetable fats and oils in the world. Although a number of nations included in Pan-America normally depend on imports for the bulk of their supplies of fats and oils, nevertheless, as a whole they normally have a net annual export balance of approximately 1.5 billion pounds of fats, oils and waxes.

Owing to the wide variety of climates and soil types, Latin America is capable of producing sufficient quantities of fats and oils to supply the entire domestic requirements of the population and in addition, supply any deficits accruing elsewhere in the Western Hemisphere. It is not intended to imply that all types of fats and oils which are normally consumed in the Western Hemisphere are at present produced in Latin America, but there is no insuperable obstacle to such production.

The temperate climate of the central portion of Argentina and the southern portion of Brazil as well as the elevated areas of the Republics lying near the equator are suited to the production of linseed, soybean, sunflower and similar cultivated oil-bearing crops. The semi-tropical areas are equally adapted to the production of castor beans, cottonseed, tung nuts and peanuts, while the tropical areas are capable of unlimited production of babassú, coconut, palm, oiticica and other tropical oil-bearing seeds and nuts.

It has been stated that the vast tropical area of Brazil could supply the entire world demand for certain types of fats and oils, and it might be stated these could be augmented by additional supplies from other countries of Latin America. Intensified exploitation of this vast reservoir of raw material merely awaits the improvement in existing, and development of additional, transportation facilities, an adequate supply of labor, and the installation of essential processing equipment.

In addition to the vast untapped resources of fats and oils which nature has provided without the intervention of man, almost unlimited additional supplies can be produced at will through the application of agricultural methods. It is certain that these resources will be developed if for no other reason than to supply the need for fats and oils within the borders of Latin America itself. As more and more of the Republics to the south of the Rio Grande become industrialized, as is occurring in the Argentine, Brazil, Chile and Mexico, increased supplies of fats and oils will be required for industrial use as well as to supply the demand for edible products which will follow with increased purchasing power of the industrial workers.

The per capita consumption of fats and oils in the United States in 1941 amounted to 82.3 pounds, distributed as follows: Edible products, 52.4 pounds; soaps and detergents, 17.4 pounds; paints, varnishes, printing inks, linoleum and other drying oil products, 8.0 pounds; miscellaneous, 4.5 pounds.

If the per capita consumption of Latin America equalled that of the United States, approximately 10 billion pounds of fats and oils would be required to supply the demand. Such a demand is unlikely to occur for many years to come, but it could readily be supplied entirely within the confines of Latin America. Not all of the Republics could supply their own needs or could participate equally in the commerce which would be created by such markets, owing to differences in climate and soil, and to the specific nature of the crops which must be grown to supply the types of fats and oils demanded. Some countries like Argentina and Brazil already have well established vegetable oil industries and produce a wide variety of oils, while others are just beginning to develop such industries, and still others have relatively little industrial production. Brazil produces annually in excess of 225 million pounds of vegetable oils, and linseed production alone in the Argentine amounts to about 1.5 million tons, equivalent to more than a billion pounds of linseed oil, annually.

Aside from the future demand for fats and oils in Latin America, there is to be considered the world markets existing under present restricted commerce and those which will exist once again when commerce is free to move unrestrictedly on the high seas. It should be possible for a number of Latin American countries to participate in these markets to a greater extent than has been the case in the past.

In any discussion of the agricultural resources of so vast an area as is comprised by Latin America, the question arises of the best mode of treatment of the subject, i.e., whether by individual countries, by specific plant sources, or

by plant groups of similar economic importance and industrial use. Each mode of treatment has its advantages and disadvantages both from the writer's and the readers' points of view. For the present presentation it would seem preferable to discuss the subject from the standpoint of individual plant sources grouped as far as possible into wild, semi-cultivated and cultivated sources.

*Babassú.* — Brazil abounds in a species of palm known botanically as *Orbignya barbosiana* and locally as babaçu or babassú. The actual extent and distribution of this palm, the number of trees, and the potential yield of babassú oil are unknown but sufficient information is available to indicate that they are unbelievably large. Some idea of their extent may be gained from the Report of the United States Vegetable Oil Mission to Brazil (1) from which the following is quoted: "The distance from São Luiz to Terezina is 280 miles . . . Starting from São Luiz outskirts to the Parnaiba River, there was practically a solid green wall of the most magnificent babassú trees seen in northern Brazil. This growth of babassú trees apparently extended for an interminable distance into the interior on both sides of the railroad.. The number of babassú trees in Maranhão has been estimated at one billion which we believe conservative."

In addition to the vast area of babassú in the State of Maranhão, large numbers of trees abound in the States of Amazonas, Baía, Pará, Piauí, Ceará, Matto Grosso, and Goyaz. Some estimates place the number of babassú palms in the State of Piauí up to twice the number in the State of Maranhão. The same or closely related species of palm are found in Central America and Mexico.

The babassú palm produces a fruit or nut which is comprised of an extremely hard shell containing a kernel which represents approximately 10 percent of the weight of the dried nut. The kernel is very rich in oil (60 percent). The oil is very similar to coconut oil and can be used for all purposes in which coconut oil is used, including free-lathering soaps, margarine and lard substitutes. Its principal use is in the production of free-lathering toilet soaps of the coconut oil type.

The babassú is perhaps the most useful of all the trees in Brazil since almost every part of this palm finds some application by the natives. The leaves and stems of the palm, the fiber of the fronds, the pith, the nut (shell and kernel) and even the spike of the palm are used. (2, page 190.)

Production of babassú nuts in Brazil amounted to 67,252 metric tons in 1939 compared to less than 20,000 tons for the 1930-34 average, and exports for the same year amounted to 41,187 tons practically all of which went to the United States. The oil is also exported, although in considerably smaller quantities than the nuts; for example, in 1941, 31,398 tons of nuts and only 1,084 tons of oil were exported through the port of São Luiz, Maranhão.

The development of the babassú industry has been seriously handicapped by lack of transportation and processing equipment. No adequate nutcracking machines have ever been developed, and consequently hand labor has been depended on to crack the nuts and separate the kernels. It has been estimated (1, page 38) that 75,000 persons are engaged in the production of babassú kernels in the State of Maranhão and that the production of 30,000 tons of kernels would require the labor of 120,000 persons for a month.

Highways are practically nonexistent in the tropical jungles where the babassú abounds; rivers often are undependable because low water during the greater portion of the year renders them unnavigable; the few existing railroads are much in need of rolling stock and improvement of the rights of way.

However, none of these obstacles are insuperable and could be overcome with adequate finances and proper application of technology. Babassú production could be increased to 200,000 tons annually with a minimum improvement in existing facilities and to almost any degree depending on the extent to which capital were invested and adequate labor and technological skill were employed.

*Coconut and related palms.* — Coconut oil which is produced from the dried meats or copra of the coconut oil palm, *Cocos nucifera*, is the principal soap oil of the world. Its use for this purpose depends on its chemical composition which consists principally of the glycerides of lauric and other short chain fatty acids. The soaps of these acids are free-lathering even in hard water. The oil is also used extensively in the manufacture of margarine, confections and other edible products.

The world production of coconut oil is unknown but exports of oil or oil equivalent copra from the principal producing countries has exceeded 2 billion pounds annually. The principal producing areas are the Philippines, Ceylon, British Malaya, and the Netherlands Indies, but the coconut palm is grown extensively throughout Oceania and elsewhere.

In Latin America the coconut palm is found along the coastal areas of practically every country and considerable numbers of trees are found in Brazil, especially in Sergipe, Baía and Alagôas. Although some oil is produced for local consumption in Latin America, very little has been exported. Negligible quantities have been exported from Argentina, Paraguay and Brazil.

Mexico has always depended on imports of copra for the production of the bulk of her coconut oil requirements. However, in recent years domestic production of copra has averaged about 30,000 tons and production is being increased by planting new trees particularly in Campeche, Quintana Roo, Tabasco and Guerrero.

A large variety of products can be produced from the coconut including dried and shredded coconut, oil and meal from the meats; fiber from both the ripe coconut and the dried fruit; and charcoal, activated carbon, gas and metallurgical coke from the shells. Considerable quantities of fresh coconuts and coconut meats have been imported into the United States from the Caribbean region primarily for edible purposes, whereas practically all of the copra for oil, or the oil itself, has come from the Far East, principally the Philippines.

It is estimated (2, page 194) that there are 5 million coconut palms in Brazil of various ages and productivity. Production of coconuts averages about 70,000 tons annually and practically all of it is consumed locally in the form of sweets or as oil in the form of margarine.

It is estimated that there are about 500,000 acres of coconut oil palms in South America and about 110,000 acres in the West Indies. In contrast to the Far East where the industry

is established on a plantation system, most of the trees are wild, consequently the yield of fruit is low in the latter countries compared to those of the Far East. There are, however, many coconut plantations in Brazil, some of them very old, often neglected and of low productivity, but there are others which are relatively young, well-cared for and relatively productive. The average yield of coconuts in well-cared for plantations of the Far East is estimated at 100 to 150 per tree and at 70 to 80 in the less well-cared for groves. In contrast to these yields, some plantations in Baía yield only 13 to 14 coconuts although the best plantations in the same State are reported to have produced 300 to 400 coconuts per tree.

The coconut palm industry is being revived in various Latin American countries. New plantations are being developed; efforts are being made to combat the various diseases to which the Cocos palm is susceptible; methods of cultivation are being adopted; and fertilizers are being applied. Improved cultural practices and adequate economic support should make possible the development of a coconut palm industry comparable with that existing in the Far East.

In addition to the coconut palm there are many other species of palms which produce fruit yielding oil so similar to coconut oil that it can be adapted to all uses for which coconut oil is used. These palms include tucum, *Astrocaryum tucuma;* murumurú, *Astrocaryum murumurú;* cohune, *Orbignya cohune;* coyol, *Acrocomia mexicana;* corozo, *Corozo oleifera;* macanilla, *Guilielma gasipaes;* and many others.

These oilseed palms flourish in the tropics and most of them have been exploited only in a minor degree. Oil is produced from a number of these palms both for domestic consumption and for export, and in some cases the nuts or the kernels are exported for crushing in other countries.

Cohune palms are found in the tropical lowlands of the Yucatan Peninsula of Mexico, British and Spanish Honduras, Guatemala and elsewhere. The coyol palm is found in Nicaragua, Costa Rica, Guatemala, Panama and other Central American countries. Corozo is found in Central America, and especially in Venezuela. Tucum, murumurú and several other species of Astrocaryum palms are found in Central and South America, including Brazil, the Guianas and Venezuela. Brazil exported more than 6,000 metric tons of tucum nuts and nearly 2,000 metric tons of murumurú nuts in 1941 in addition to over 300,000 pounds of murumurú oil.

It is reported that Colombia produces about 1,500 barrels of a coconut-type oil from noli and corozo palm nuts; also that El Salvador possesses a species of palm, *Brahea salvadorensis,* which produces 3,000 to 4,000 tons of high oil-content nuts.

The number and extent of oil-bearing palms of all types which flourish throughout Latin America cannot be even vaguely estimated but they must exceed many millions.

Practically all of the nuts from the palms mentioned above (*Cocos nucifera* excepted) possess a thick, hard shell which is difficult to crack by mechanical means. A wide variety of nutcracking machines have been built from time to time and tried out in various countries. A few of them, generally built locally, have been successful, but most of them can be operated for only a few months before extensive repairs or replacements are necessary, hence these nuts are still cracked primarily by hand, a process which is both slow and in the long run expensive even with cheap labor. Until really efficient, rugged and relatively cheap nutcracking machines are developed the production of oil from the hard-shelled palm nuts will be limited.

*Dende palm.* — Palm oil is produced from the fleshy pericarp, and palm-kernel oil from the seed kernel, of a number of varieties of the African palm, *Elaeis guineensis.* These two oils, although derived from the same fruit, are quite different chemically. Palm-kernel oil is somewhat similar to coconut oil in its composition and uses, whereas, palm or pericarp oil is an oil intermediate in composition and properties between coconut oil and edible oils like cottonseed and peanut.

The African palm was introduced into Central and South America, especially in British Guiana, and in the Amazon Valley of Brazil. In the latter country it is known by the Portuguese designation dende palm. It has been estimated (1, page 76) that there are more than 1.5 million dende palm trees in the State of Baía but the commercial production of palm oil is negligible. However, the natives grow the dende palm in their back yards and prepare oil from it for culinary uses in the home. Recently, interest has been aroused in the development of a plantation system in Brazil similar to that of the Far East.

*Oiticica and related oils.* — Oiticica oil is obtained from the seed of the oiticica tree, *Licania rigida,* which grows wild, usually in dense groups, in the rich alluvial soil along the river banks and lakes in northern Brazil. The tree attains an average height of 16 meters and has thick bright green foliage even in times of severe drought. Its trunk is short and sturdy, about 1.0 meter in diameter, and is attached to the soil by long, strong roots which makes it possible to withstand prolonged drought. The tree begins to bear seeds in 4 years, reaches maximum production in 10 years, and has an estimated life of 100 years. The adult tree produces about 150 kilos of seed annually. The seed consists of about 74 percent kernel containing 50 to 70 percent oil.

In general, the uses of oiticica oil are the same as those of tung oil, *i.e.,* in the manufacture of fast-drying varnishes and enamels, in paints, linoleum, waterproofing agents, and synthetic resins. The oiticica oil industry was scarcely known outside of Brazil prior to 1935. For a number of years thereafter, great secrecy surrounded the origin of the oil, and the Brazilian government has taken elaborate precautions to protect the industry, even prohibiting the export of seed.

Actually, it was known more than a century ago that oiticica oil was an excellent drying oil. About 70 years ago, the industrial exploitation of oiticica seed was attempted at Fortaleza, Ceará. The venture failed and was not revived until 1927 when the oil was extracted and used by one of the largest paint factories in Brazil. From that time forward the production of oil continued to increase and probably will for an indefinite period. The 1940 production of oiticica oil exceeded 17 million pounds of which about

16 million pounds was exported, principally to the United States and Great Britain.

The State of Ceará usually accounts for 80 percent of the production of oiticica oil, the remainder coming from the States of Paraiba (8.9 percent), Rio Grande do Norte (6.5 percent), Piauí (5.5 percent) on the basis of the 1939 production.

Since the United States normally consumes annually in excess of 100 million pounds of tung oil which can be replaced by oiticica oil, the potential market for the latter oil in this country is indeed very great.

In recent years a number of other sources of rapid drying oils have been discovered in Latin America and although none of them have reached commercial production their future exploitation appears to be only a matter of time.

One of these newer oils has been designated Mexican oiticica or cacahuananche oil. The oil is produced from the seeds of *Licania arborea*, a tree which is native to Mexico and Central America. The tree is known by a variety of local names such as cacahuananche in Mexico, alcornogue in Costa Rica, and encina in Honduras and Guatemala. It is also called cana dulce and guirindal in other countries.

The seed kernels comprise about 45 percent of the whole fruit and contain about 70 percent oil. The oil is apparently similar to oiticica oil from Brazil and can be used for the same purposes.

Several species of trees are known which produce seeds containing an oil similar to Chinawood or tung oil. One of these, *Garcia nutans*, is found in southern Mexico, Venezuela, Colombia and in the West Indies. The nut contains approximately 80 percent of kernel containing about 55 percent of oil. The oil is similar to tung oil but superior to it in some respects for the production of varnishes and other polymerized products.

Another species of tree, known as garampara, *Ouratea castanifolium*, grows wild in great numbers in the States of Pará, Maranhão and Piauí in Brazil. Both the kernel and outer husk of the nut contain oil but of different types. The oil derived from the kernels appears to be valuable in soap-making while the oil from the husk is very similar to tung oil and is, therefore, useful for the production of fast-drying varnishes and other protective finishes.

No doubt many other species of plants indigenous to Latin America will be found to be valuable as sources of fast-drying oils similar to tung and oiticica. Such oils are always in great demand and their commercial exploitation, especially by plantation systems, should be undertaken.

*Cocoa and ucuúba butters.* — Cocoa butter is produced from the seeds or so-called beans of the tree, *Theobroma cacao*, and is obtained primarily as a byproduct in the manufacture of beverage cocoa. The tree is indigenous to the Amazon Valley but is grown extensively in many tropical countries. Africa accounts for about two-thirds of the world production and Latin America about one-fourth. The butter which is a solid fat at room temperature is used extensively in the confectionery industry and in the manufacture of pharmaceuticals.

Cultivation of cacao was carried out by the Aztecs and in Mexico its cultivation has always been practiced on an intensive scale. Cultivation of cacao in Brazil was ordered by the Royal Charter in 1678 and has been carried on since then in various states bordering the Amazon, especially in Baía, Espirito Santo, Minas Gerais, Estado de Rio, Pará and Amazonas. Baía, however, produces 95 to 98 percent of the Brazilian crop. Most of the crop is exported and the cocoa and cocoa butter is, therefore, generally produced outside of the areas in which the trees are grown. For example, in 1939 Brazil produced 134,758 tons of cacao and exported 132,155 tons. When prices are too low to justify exporting the seed or beans, cocoa butter is extracted in the country of origin. Brazil is second only to the Gold Coast as a producer of cacao and in recent years has produced more than twice that of the other Latin American countries combined. The other principal producing countries of Latin America are Dominican Republic, Ecuador and Venezuela.

A solid fat similar to cacao butter is produced in Brazil. It is known as ucuúba butter and is produced from various species of *Myristicaceae*. The principal producing area is the State of Pará in Brazil which produced more than 2.6 million pounds in 1940. Total exports from Brazil amounted to more than 2.3 million pounds in 1941.

The trees from which ucuúba nuts and oil are obtained apparently grow wild along rivers. The tree begins to produce fruit when 2 years old and reaches full bearing at 10. The nuts fall into the rivers and are fished out with nets. The butter or fat is obtained by pressing and is exported in drums.

*Castor beans.* — The seed, or so-called bean, of the castor plant, *Ricinus communis*, is the source of an important oil of commerce. This oil, generally known for its medicinal properties is, however, much more important as an industrial raw material and finds its principal uses in the drying oil and synthetic resin industry, either directly or after dehydration to increase the unsaturation of its constituent acid, ricinoleic acid. It is used in the manufacture of synthetic resins, paints, varnishes, printing ink, linoleum and related products; and after sulfonation in the textile industry and in breaking the oil-water emulsions obtained from petroleum wells. It is also used as a lubricant, shock absorber and hydraulic brake fluid, and for many other purposes.

The plant is a perennial in the tropics and is grown as an annual in temperate climates, therefore, it can be grown throughout a vast area of Latin America. Castor beans are produced in commercial quantities in Brazil, Argentina, Haiti, Nicaragua, Ecuador, Mexico, El Salvador, and Cuba. Originally, most of the seed came from wild plants of which large numbers are found in Brazil and to a lesser extent in Argentina. More recently, however, castor beans have been grown as a cultivated crop, especially in Haiti, Mexico, and other countries where castor production has been recently introduced. Even in Brazil and Argentina much of the production now comes from cultivated plants. The State of Baía in Brazil, for example, exported over 65,000 metric tons of castor beans in 1941. Total exports from all of Brazil for the same year amounted to 221,812 metric tons, in addition to 10 million pounds of oil. The seeds of the wild castor are very variable in size and oil content. Brazilian castor seed has been found to

vary from 30 to 60 percent in oil content although the average for seed from temperate areas is 46 to 47 percent, and above 50 percent in seeds from the more tropical regions. The newly developed varieties which are being grown in Haiti, Mexico, El Salvador and elsewhere in this region generally produce large seeds containing 50 percent or more of oil.

Brazil is the largest producer of castor beans not only in Latin America but in the world. Until recently, first place in the world's production of castor seed was held by British India, but owing to declining production in India and increasing production in Brazil, the latter country is now the foremost producer.

In recent years, Latin America has produced considerably more than 50 percent of all of the castor seed which entered world commerce and in 1938 accounted for 74.6 percent of the total.

Until recently the Argentine ranked next to Brazil among the Latin American countries in the production of castor seed. Production amounted to 17 million pounds in 1936 and has probably increased appreciably since then. The other Latin American Republics produce relatively small quantities of castor beans in comparison with Brazil and Argentina. About 2,000 tons are harvested annually in El Salvador but it is estimated that 10 times this quantity could be picked if prices were sufficiently attractive. A number of Caribbean and Central American countries, notably Haiti and El Salvador have carried out extensive breeding programs designed to develop improved varieties and strains of castor beans. The production of castor beans has also been stimulated in Mexico and the United States has agreed to purchase 75,000 tons of these seeds during the current year and 150,000 tons during the succeeding year (3). The significance of this production can be better appreciated when it is realized that Mexico has been a minor producer of castor beans and has generally been a net importer of castor oil. However, production of castor beans has been steadily increasing in Mexico, having increased from 12,198 short tons in 1938 to 22,046 tons in 1942. It has recently been reported that the 1943 crop of castor beans in Mexico has been a failure owing to severe drought in the producing areas.

This stimulation of castor production in Latin America assures the Western Hemisphere of adequate supplies of castor oil and will produce a surplus for trading outside of this hemisphere.

*Carnauba, uricurí, candelilla and other waxes.* — Carnauba and uricurí waxes are products indigenous to Brazil. No other country produces these waxes or any other wax of similar properties. Both are highly prized because of their hardness, high gloss and dispersability in the form of emulsions, consequently they are largely employed in the manufacture of floor, metal and furniture polishes and for other purposes.

Carnauba wax is produced from the leaves or fronds of the carnauba palm, *Copernicia cerifera,* and uricurí from the leaves or fronds of the uricurí palm, *Syagrus coronata.* Many palms secrete waxy protective coatings on their fronds, especially in torrid climates, where for many months at a time little or no water reaches the root system. The same species of palms when situated in more moist climates will elaborate waxes within the frond but only in dry or torrid climates is the wax deposited on the outer surface where it serves to reduce the evaporation of water. Only where the wax is heavily deposited on the surface of the fronds is commercial exploitation feasible. For this reason the principal producing areas of carnauba are confined to the States of Ceará and Piauí and to a lesser extent to Rio Grande de Norte, Maranhão, Baía and Paraiba, while production of uricurí is confined to the "caatinga" lands in the dry areas of southern Baía although this palm is also found in Minas Gerais and Pernambuco.

Until quite recently both waxes were recovered from the fronds by rather primitive processes but recently several processes have been introduced for separating the wax by mechanical means.

Production of carnauba wax in Brazil amounted to 11,476 tons in 1939 of which more than 10,000 tons was exported. Uricurí production is of recent origin having been first produced in 1935. Figures for present production are not available but exports in 1940 amounted to more than 2 million pounds.

Candelilla wax is found on the stems of a plant of the *Euphorbiaceae, Pedilanthus pavonis,* which grows in the semi-arid regions of northern Mexico. The plant, which grows to a height of 3 to 5 feet, consists of a bundle of stalks without leaves. Each plant yields 3.5 to 5 percent of wax.

Beeswax, although elaborated and deposited by various species of bees is derived indirectly from plants. Many Latin American countries have extensive bee culture and produce and export considerable quantities of beeswax. Brazil is the largest exporter with 965 tons in 1939. In 1938 Chile exported 270 tons, Dominican Republic 227 tons, Cuba 201 tons and Mexico 111 tons.

*Linseed.* — The foregoing has dealt almost entirely with sources of oil from wild or semi-cultivated plants or with plants which are found in various states from uncultivated to highly cultivated as is the case with the castor plant.

Besides these sources of vegetable oils Latin America produces very considerable quantities of oil as the result of large and small scale farming. Outstanding among the oil-seed crops in Latin America is linseed. By far the largest producer of linseed in the Western Hemisphere is Argentina, in fact this country is now the world's largest producer of linseed for oil. Aside from Argentina, Russia, the United States and British India are the next three largest producers in the order named. However, only Argentina and British India are large exporters. Uruguay is the only other large producer, though other countries, notably Brazil, produce minor quantities of linseed.

Linseed production is centered in the Paraná River basin in Argentina, the Rio de la Plata region of Uruguay and the State of Rio Grande do Sul of Brazil. Production of linseed has been declining in the Argentine and Uruguay in recent years but increasing in Brazil. Production of linseed in the Argentine averages around 1.5 million metric tons annually. Production in Uruguay in 1942 is estimated at 49,000 tons, whereas, Brazilian production in 1939 amounted to 13,000 tons. All of Brazil's production is consumed domestically and additional amounts are imported from Uruguay and Argentina.

Argentina and Uruguay depend on exports for the disposition of their linseed crop and owing to the disruption of foreign markets tremendous surpluses have accumulated over the past several years. In 1942 the surplus in Argentina amounted to 3.2 million metric tons as a consequence of which the Argentine Government disposed of large quantities of seed as fuel and of linseed oil as fuel oil. As a result of consumption in these channels the surplus was cut to about a million tons.

The production of linseed has been increasing in Mexico and now amounts to about 40,000 metric tons annually, most of which is produced in the State of Jalisco and in the Yaqui Valley in the State of Sonora.

*Tung oil.* — The demand for fast-drying oils has led to extensive efforts in recent years to introduce the tung or Chinawood tree into various Latin American countries. Originally a native of China which is still the world's largest producer of Chinawood or tung oil, the cultivation of the tung tree, *Aleurites fordii* and *Aleurites montana,* has spread to many other countries and notably to the United States.

The hardier *A. fordii* was introduced into the United States for propagation in 1905 and since then has become established in the southeastern and Gulf Coast States. The census of 1940 showed that 2,304 farms had nearly 13 million trees growing on an estimated acreage of 200,000. Production of tung oil in 1942 amounted to 5 million pounds or about 4 to 5 percent of the normal consumption of the United States.

The successful introduction of the tung tree in the United States inspired other Western Hemisphere countries to attempt its cultivation. According to the 1938 report of the International Institute in Rome (4) experiments in tung culture are being conducted in Costa Rica, Cuba, Dominican Republic, Guatemala, Haiti, Honduras, Uruguay, Paraguay, Brazil and Argentina. It may be said that tung cultivation extends from southern United States to northern Argentina but in Latin America only Paraguay, Brazil and Argentina are commercial producers.

Tung oil and nuts appeared in the foreign trade statistics of Paraguay for the first time in 1941 and in 1942 it was estimated that about 1,200 to 1,500 acres were in cultivation in the Hohenau Colony about 50 miles northeast of Encarnación. Smaller acreages were reported in other areas of Paraguay.

In the Argentine, tung growing is confined to the northeastern part of the country principally in the Territory of Misiones and adjoining sections of the Province of Corrientes. The total number of tung trees in Argentina at present is not known but the last agricultural census (1936-37) showed 370,622 trees on 8,406 acres. However, in 1940 the Argentine Government announced a planting program of 100,000 trees annually. Apparently sufficient trees are in production to supply the domestic needs of Argentina for tung oil since no tung oil has been imported since 1938. The 1943 production of tung oil in Argentina is estimated to be about 1,000 tons.

Of the Latin American countries, Brazil is by far the most important producer of tung nuts although the output of oil is still small owing to the fact that most of the nuts are being used for seed purposes.

The principal growing areas are the States of São Paulo, Paraná, Rio Grande do Sul and Minas Gerais. Although the climate of São Paulo ranges from tropical in the north to temperate in the southern plateaus, tung trees are being grown all over the State. It is estimated that there were about 2 million tung trees in Brazil in 1942 of which approximately 725,000 were in São Paulo, 347,000 in Paraná, and 500,000 in Rio Grande do Sul. In the 1942-43 planting season approximately 1.5 million additional trees were planted in the State of Paraná (5). Most of these trees were interplanted between coffee trees.

*Sunflower.* — Among the cultivated edible oil crops of importance to Latin America are sunflower, cottonseed, peanuts and rapeseed. The production of all four is well established and continually expanding. The increased production of sunflowerseed oil in Argentina is little short of phenomenal and is paralleled only by the expansion in soybean production in the United States.

Cultivation of the sunflower began about 1900 in the Argentine where it was introduced by Russian emigrants who settled in the provinces of Buenos Aires, Santa Fé and Entre Rios. Until after World War I, however, crops were small and crop estimates were not published until 1933-34.

Production of sunflowerseed in Argentina amounted to only 4,483 metric tons in 1932, but in 1941 had increased to 401,708 metric tons or a ninetyfold increase (6). In 1942 production again increased to about 650,000 tons and places the Argentine second in world production of this oilseed.

In 1941 the production of sunflowerseed oil in the Argentine amounted to 100,992 metric tons or 70 percent of the entire edible oil production of the country. Until recently both oil and seed were exported but owing to the increased domestic demand for edible oils all exports of these oils have been prohibited by the Argentine Government. It is interesting to note that Argentina's estimated requirements for vegetable oils are around 220 million pounds annually and that her per capita consumption of edible oils has increased from 6.4 pounds in 1910 to 17.9 pounds in 1940.

Production of sunflowerseed in Uruguay in 1943 was estimated at 15,000 metric tons which is much smaller than usual owing to prolonged drought during the current growing season. Similar crop estimates for 1942-43 for Chile forecast a production of sunflowerseed at 12,861 metric tons.

The cultivation of sunflowers for oil has been established in Brazil in recent years but oil production is still small and in 1940 did not exceed 140 metric tons. Only minor quantities of sunflowerseed oil are produced elsewhere in Latin America but production is being extended and it appears that this oil will become the predominate edible oil south of the Rio Grande.

*Cottonseed and cottonseed oil.* — Since cotton is indigenous to many Latin American countries it is not surprising that it should be extensively grown wherever soil and climatic conditions are favorable. Although nearly every Latin American country produces some cotton

the foremost producers are Brazil, Mexico, Argentina, and Peru in the order named.

The Portuguese found cotton growing wild when they first set foot in Brazil; cotton cloth has been found in the prehistoric graves of the Incas in Peru; and in Argentina mummies, antedating the advent of the Spaniards, have been found swathed in cotton fabrics. In Haiti cotton grows wild on the semi-arid plateaus and plains.

In most of the producing areas cotton has been in cultivation for many years but in most of them marked increases have occurred in the past 25 to 35 years or even more recently.

Cottonseed, which is produced as a byproduct of the ginnning of cotton, is one of the most important sources of edible oil used in the production of shortening, oleomargarine, mayonnaise and salad dressings, and as a cooking oil.

Although reliable statistics are available for the production of cotton in most Latin American countries, similar statistics are not generally available for the production of cottonseed and cottonseed oil. An effort has been made to estimate the production of seed on the basis of the reported figures for the production of cotton (7). Using the ratio of 40 to 60 for cotton to cottonseed, which is an approximation based on United States production, the estimated production of cottonseed was calculated for various Latin American countries. These figures are given in the table. These data are approximations since the ratio of lint to seed varies with variety, method of ginning, and with other factors, but they are sufficiently accurate to furnish a picture of the relative importance of cottonseed production in Latin America.

To determine the production of cottonseed oil in those countries where statistics are unavailable is even more difficult and uncertain because there is no way of estimating the proportions of the seed which is exported, reserved for replanting, for feeding to live stock, and for fuel and fertilizer. Potentially the production of oil would appear to be very large. Assuming a total production of 1.25 million metric tons of seed and 80 percent crushed for oil with an average yield of 15 percent of oil, production of oil would exceed 150 million kilograms or approximately 330 million pounds.

Most of the larger producing countries as well as some of the smaller ones crush cottonseed for oil but they also export seed to other countries for crushing, therefore, the production of oil within a given country is no measure of the amount of seed produced or which is available for domestic crushing. However, a few figures will give some idea of the magnitude of the production. Brazil, for example, produced 75,705 metric tons of cottonseed oil in 1939. In 1942 Peru produced 17,307 tons and Argentina produced 10,228 tons in 1941 which is approximately half as much as was produced in 1940. El Salvador produced 550 tons of oil and in addition exported seed to other countries for crushing.

PRODUCTION OF COTTON AND ESTIMATED PRODUCTION OF COTTONSEED FOR VARIOUS COUNTRIES

| *Country* | *Year* | *Cotton* | *Estimated production of cottonseed* |
|---|---|---|---|
| | | *metric tons* | *metric tons* |
| Brazil | 1941 | 545,645 | 818,467 |
| Mexico | 1942 | 87,491 | 131,236* |
| Argentina | 1942 | 80,869 | 121,303 |
| Peru | 1941 | 70,998 | 106,497† |
| Colombia | 1942 | 7,916 | 11,874 |
| Paraguay | 1942 | 6,797 | 10,192 |
| Nicaragua | 1941 | 6,514 | 9,771 |
| El Salvador | 1942 | 4,400 | 6,600 |
| Guatemala | — | 3,300 | 4,950 |
| Haiti | 1941 | 3,225 | 4,837 |
| Venezuela | 1942 | 3,037 | 4,555 |
| Ecuador | 1941 | 2,130 | 3,195 |
| Costa Rica | 1942 | 334 | 501 |
| Dominican Republic | — | 150 | 225 |
| Cuba | — | 20 | 30 |

* 1942 yield reported to be 198,414 short tons.

† 1942 estimate 131,174 short tons.

The average export of cottonseed oil or oil equivalent seed for the period of 1935-38 were: Mexico, 3,426,000 pounds; Central America and Caribbean countries, 303,000 pounds; and South America, 92,823,000 pounds.

*Peanut Oil.* — The cultivation of peanuts, especially for the production of oil, is practiced in a number of Latin American countries. In 1941, 50,450 metric tons of peanuts were crushed for oil in Argentina to produce 17,694 tons of oil. In 1943 peanut production in the Argentine amounted to 94,400 metric tons.

Compared to Argentina's production of peanut oil, that of Brazil, namely, 104 tons in 1939 is relatively small. However, production has been rapidly expanding in Brazil and the 1943 crop is estimated at 25,000 metric tons. The Dominican Republic produced 4,463 tons of peanuts in 1942, most of which were crushed for oil in an oil mill in Ciudad Trujillo.

Peanuts are grown throughout Mexico and especially in the State of Jalisco. Production increased from 13,000 short tons in 1938 to more than 44,000 tons in 1942. Prior to 1930 peanuts were consumed almost entirely in the form of nuts rather than oil. By 1942 approximately 9,500 tons of peanuts were crushed to produce about 3,000 tons of oil.

It may be assumed from the recent trend in the production of peanut oil in Latin America that expansion in production of peanuts will continue both for consumption as nuts and for the production of oil.

*Miscellaneous sources of vegetable oils.* — In addition to the specific oils and oilseeds which have been discussed above there are many others which are produced in varying quantities. Some countries may produce relatively large quantities of these oils whereas they may be wholly unknown in others. For example, Argentina produces relatively large quantities of rapeseed oil, and this oilseed is in fact Argentina's third largest source of edible oil. In 1941, production in Argentina amounted to 48,436 metric tons of seed while production of oil amounted to 15,134 tons.

Sesame is grown in varying quantities in several Latin American countries. Nicaragua produced 8,950 tons of sesame seed in 1942. El Salvador produces about 1,000 tons. Production of sesame in Mexico is appreciable having increased from 28,338 short tons in 1938 to more than 66,000 tons in 1942. Not all of the sesame seed is, however, used for oil production.

Some of the oils of Latin America are produced as a result of surplus crops which are normally grown for other purposes. For example, owing to the extremely large surplus of coffee in Brazil in recent years, increasing quantities of the berries have been diverted to oil production and in 1939 more than a thousand tons of coffee oil was produced.

For a similar reason small amounts of walnut oil are generally produced in Brazil and in recent years production of this oil has varied from 25 to more than 40 metric tons annually.

Brazil produces varying quantities of oils from plant sources almost unheard of elsewhere. A list of Brazilian vegetable oil sources (2, page 135) contains such names as andiroba, jerjelim, pracaxí, macaúba, cumarú, carauá and others

How many unexploited natural sources of vegetable oils exist in Latin America is difficult to imagine. Certainly there are many wild plants yielding seeds, nuts, fruits, berries, gourds, and tubers, which are potential sources of oils. New sources are being constantly discovered. One of these newer sources is *Cresentia cujete*, a member of the *Bignoniaceae*. This gourd which grows in Venezuela, Cuba, El Salvador, Brazil, Costa Rica, Colombia, Yucatan, and elsewhere has been found to produce a good quality edible oil. The dried pulp and seed yield 25 to 30 percent of an oil very similar to olive oil. It is interesting to note that heretofore no member of the *Bignoniaceae* has ever been known as a source of vegetable oil.

In addition to indigenous oil-bearing plants which might be brought under cultivation, there remains also the possibility of introducing new crops into many areas of Latin America from outside sources. For example, most areas of Argentina, as well as lesser portions of other countries, are ideally adapted to the cultivation of soybeans. The production of corn oil could be greatly expanded in Argentina with increased grinding of corn for the production of cornstarch.

As stated in the opening paragraphs, Latin America is already a foremost producer of vegetable fats and oils and its potential resources are almost unlimited. It may be confidently expected that the exploitation of these vast reservoirs of vegetable fats and oils will continue at an accelerated pace for many years to come.

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BRITTAIN B. ROBINSON: **Aims, Scope, and Future of Research on Fiber Plants in Latin America:** — The production in the Western Hemisphere of the seven major plant fibers other than cotton, namely, abacá, sisal, henequén, jute, flax, hemp and kapok, represents approximately 4 per cent of the World's production, and the other 96 per cent is produced in the Eastern Hemisphere.

As the Americas are not important producers of the major plant fibers, it is not generally known how numerous are industries connected with the production of various fiber plants in Latin American countries. A few individuals are familiar with the extent and recent rise in importance of cotton cultivation in Latin American countries, and possibly with henequén production in Mexico and Cuba, but other fiber industries are relatively unknown.

The plant fiber industries listed in the table on the next page are among the more important existing in Latin America.

These listed fiber industries are all well established, and contribute to the economic prosperity of the State or local district where grown within the various countries. In addition, there are fiber industries utilizing other fiber plants that are of minor importance in world commerce but contribute materially to the economy and mode of living of the Native Indians in the less developed isolated areas. Many of these industries have existed for years, and export trade of these fiber materials are well established. In general the industries have been for the production of raw fiber for export, and there have not existed extensive manufacturing industries for domestic consumption or the export of manufactured products has not been developed. The exports of manufactured toquilla (Panama) hats from Ecuador, henequén cordage from Mexico and Cuba are a few exceptions. In the case of fique in Colombia, cabuya in Ecuador, and letona in Salvador, the production in the past has been primarily for domestic consumption of manufactured cordage and bagging material.

Textile and cordage manufacturing investments in Latin America are increasing. The principal fibers manufactured are cotton and jute. These industries are partly protected by tariff laws, and several Latin American countries, because of nationalist policies and in order to conserve and protect their home industries, have required the use of native fibers or "national" fibers by their home manufacturers. This policy undoubtedly will be a contributing factor for greater future use of national fibers as their

quality and manufacturing are improved by continued production.

The second World War has materially stimulated production of plant fibers in Latin America due to the lack of supplies in international trade of fibers formerly available from the Netherlands East Indies, the Philippines, and eastern Asiatic countries. The stimulation of production is not only due to the attractive war prices making it possible for more profitable production of the crops in Latin America, but it has been necessary for the Latin American countries to stimulate production and to conserve and regulate the consumption of their own fibers in order that their own industries could be supplied with necessary twines, cordage, and bagging.

The production of fiber plants in Latin America has many advantages. With the exception of cotton, practically all of the fiber plants produced in Latin America are non-competitive crops with the United States. The United States offers an attractive market for all of the plant fibers except cotton, and this market serves to stimulate international trade within the hemisphere and aids in the prosperity of all.

In the immediate post-war period following World War II, many adjustments in the agriculture of Latin America are likely to occur, and it is possible that those may include a permanent expansion in the production of domestic plant fibers. To aid in expansions which may occur in fiber industries in Latin America, and to maintain a position in the highly competitive international trade, it is important that these various industries be aided and guided through a well planned program to which research may contribute materially.

The scope of the future research with fiber plants should begin with a coordinated study of problems in which producers, processors, distributers, manufacturers, and government agencies are equally represented. A coordinated program including all fields of the industry is advisable since single isolated investigations are frequently limited in scope and value.

Practical research seems to be of primary importance in these fiber industries where little modern scientific research particularly applicable to these countries has been undertaken in the past. It is possible for more theoretical, fundamental and intensive research to be done in research institutions in Europe and the United States and for the results to be applied in Latin America. Practical research in Latin America should include field production studies and pilot mill processing to determine fundamental practical problems that govern the local production.

With such wide differences of environmental conditions ranging from tropical to temperate, arid to humid, in addition to variations in many other factors that enter into production, it is likely that research will be confined largely to plants that are known to be adapted to local conditions but studies should also include new introduced fiber plants.

*The more important plant fiber industries of Latin America:—*

| COMMON NAME: | BOTANICAL NAME: | LOCATION OF PRODUCTION: |
|---|---|---|
| Cotton | *Gossypium* spp. | Brazil, Argentina, Mexico, Peru, Paraguay, and in smaller amounts in other countries. |
| Henequén | *Agave fourcroydes* | Mexico and Cuba |
| Sisal | *Agave sisalana* | Haiti |
| Salvador sisal | *Agave letonae* | Salvador |
| Ixtle Fibers | *Agave lecheguilla*, *Agave funkiana* and *Samuela carnerosana* | Mexico |
| Cabuya | *Furcraea* spp. | Costa Rica and Ecuador |
| Fique | *Furcraea macrophylla* | Colombia |
| Caroa | *Neoglaziovia variegata* | Brazil |
| Phormium | *Phormium tenax* | Chile and Argentina |
| Flax | *Linum usitatissimum* | Peru, Chile, Argentina and Brazil |
| Hemp | *Cannabis sativa* | Chile and Argentina |
| Jute | *Corchorus* spp. | Brazil |
| Guaxima | *Urena lobata* | Brazil |
| Papoula do São Francisco | *Hibiscus* spp. | Brazil |
| Abacá | *Musa textilis* | Panama, Costa Rica, Honduras, and Guatemala |
| Kapok | *Chorisia insignis* | Ecuador |
| Piassava | *Attalea funifera* and *Leopoldina piassava* | Brazil |
| Toquilla | *Carludovica palmata* | Ecuador |

Practical research in agriculture should include a study of adaptation, economic processing of high quality fiber, and marketing studies. Adaptation studies include usual plant breeding and agronomic studies involving selection of desirable high yielding varieties adapted to the production of high yields under the existing local environmental conditions of soil, weather, insects, diseases, etc. It is thus possible for the soil scientist, agronomist, plant physiologist, plant pathologist, entomologist and other biologists to contribute in a program of this nature. The agricultural studies may determine that a crop grows well in a country but there are other factors that may govern its successful production. For example, jute grows well in the Mississippi delta of the United States and hemp in the fertile humid Corn Belt area of the United States, but economic factors of production and consumption impede these crops from becoming major crops in the United States. Economic management studies should not be overlooked in either the production or marketing of the product. Public attention has been directed to the fact that certain rather strategic agricultural products exist in Latin America but are not available to convenient markets. Some fiber products are in this category. It has been stated that a large percentage of the Ecuadorian kapok is not marketed due to lack of roads to bring the crop to market. In

Central America wild kapok trees, pochote, *Ceiba aesculifolia* and *Ceiba acuminata* are usually not in sufficient numbers in any area to make economical harvesting and marketing of their valuable floss practical. Large manufacturers prefer to pay better prices to distributors with dependable qualities and quantities of plant fiber materials. Cotton, sisal, henequén, Chilean hemp, toquilla hats and Brazilian piassava products have established well earned places in trade because of their dependable supplies and established qualities. Other fiber industries are not of sufficient size or old enough to have gained that recognized degree of stability that is necessary to insure their permanency.

Economic production problems as influenced by climate, labor and machine application should all be included in the practical agricultural and economic fundamental research studies where the services of agricultural engineers and production farm management specialists can be utilized.

The aims of research in Latin America are numerous. The agricultural prosperity of many Latin American countries is not as great as desirable. The present crop system in many countries is restricted to one or two money crops, and there is need for additional less competitive crops that can be produced by the farmers. Fiber plants enhance this possibility with the United States market close at hand. Many of the fiber plants are tropical plants, and cannot be grown in the United States commercially. Others are adapted to temperate areas but seem to have better possibilities of being produced economically in Latin America than in the United States.

Many fibers are of strategic or critical importance to the Western Hemisphere as has been demonstrated by conditions arising during the present war. Efforts should be made to grow the strategic and critical fibers more extensively in the Western Hemisphere. Soil and climatic conditions are sufficiently diversified that it is possible for the Americas to become self sufficient in the production of these strategic fibers, should the reasons justify such a program. Among the fibers which are particularly important in this respect which are not produced in sufficient abundance in the Western Hemisphere at present are abacá, sisal, jute, flax, hemp and kapok. Other plant fibers of importance that might be more extensively studied and possibly grown in the Western Hemisphere are loofah sponges, *Luffa cylindrica;* caroa, *Neoglaziovia variegata*; sansevierias; furcraeas; and malvaceous fibers.

Research should aim to collect authentic information upon which to base recommendations for the culture and processing of the fiber plants. Such information is obtainable by conducting and recording experimental data of crops under different climatic and soil conditions and a proper coordinated program should make this information available to all interested parties.

It has frequently been assumed that many of the fiber industries have prospered in the Orient and the South Seas because of cheap labor conditions. The application of mechanical processes to different phases of fiber production, preparation, and transportation, should be fully investigated to reduce labor requirements of these industries in the Western Hemisphere. Farmers seem to have become more mechanical minded, and are not willing to undertake culture of new crops that cannot be produced by mechanical means.

Nearly all Latin American countries have a nucleus foundation for a beginning in future research with fiber plants. Experiment Stations exist in most countries, but many have not been adequately financed and directed in the past. With better coordination and understanding of the basic economic problems for study, and a support of the agricultural research problems by coordinating an approved program by manufacturers, processors, producers, and government agents, the financial support of these institutions should be more liberal, and the basic problems studied should be ones of more importance than problems undertaken in the past.

The Office of Foreign Agricultural Relations of the United States Department of Agriculture has an active role in furnishing and financing trained specialists to direct research at Experiment Stations in numerous Latin American countries and has provided funds for such research. These funds are directed to promote non-competitive products and under this classification fiber plants would seem to justify attention.

In addition to the present agricultural experiment stations, a new institution of the Pan American Union known as the Inter-American Institute of Agricultural Sciences has been established at Turrialba, Costa Rica. All the Republics in this hemisphere have shared in the creating of the institute. It is supported by grants in aids by the United States Government. This foreign policy of friendship and cooperation among the American Nations is a policy that seems well established in the United States and one which may be expected to continue after the war. There is definite need for continued friendship between all American countries which will become greater and greater in the future. This Institute of Agricultural Sciences which will contribute primarily to tropical agriculture should become more and more of a contributing factor to agricultural prosperity in Latin America.

In addition to these federal research programs, there are private agencies that can and are playing a major part in contributing to future agricultural prosperity through research. In a number of Latin American countries these independent agricultural organizations are well established and have made an excellent beginning in research.

It is satisfying to know that there exists already a foundation upon which to plan and build future research in Latin America.

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F. A. MOTZ: **On Fruit Production in South America:** — South America, because of its wide range of soil and climatic conditions, produces or is capable of producing almost all the fruits that are grown today. Many of the tropical and subtropical fruits that now provide employment, enjoyment and health for millions of people throughout the world were first discovered in the Americas. The Navel orange, for example, which is indigenous to Brazil, was first introduced into California and from there distributed to many countries. Others of the more common tropical fruits that originated in the Americas

and have traveled far are the pineapple, avocado, cashew, cherimoya, papaya, granadilla, guava, and sapodilla.

On the other hand, deciduous fruits that are indigenous to Europe, Asia, and other parts of the world have been successfully introduced into South America and under favorable conditions have become important commercially. At higher altitudes, they are grown even in those countries lying within the tropics. Where temperate climatic conditions prevail as is the case in Argentina and Chile, many varieties of apples, pears, stone fruits and grapes reach a high state of perfection.

Of the various South American countries, Brazil is noted principally for its citrus fruits, pineapples and bananas. Argentina and Chile are important for their commercial development of deciduous or temperate-zone fruits.

When we restrict ourselves in the following accounts to the ABC countries it is only because of the lack of first-hand knowledge of the fruit industries of the other countries. It is hoped that studies can be undertaken one day in some of the other countries in order to complete the South American fruit chapter.

*Argentina* is the most important producer of deciduous fruits in South America. About a third as large as the United States, the country has an abundance of fertile soil and an amiable climate. It is known chiefly because of its livestock and cereal industries but its success in the cultivation of specialized crops, such as apples, pears and grapes, is also recognized.

Because of its wide range of latitude, Argentina is capable of growing practically all kinds of fruits. In the northern and northeastern parts of the country, citrus and subtropical fruits do very well, while deciduous fruits are grown chiefly in the southern, western and eastern areas.

During the last 12 to 15 years commercial fruit growing has been developed in several widely scattered zones, each with its own particular set of soil and climatic conditions. The fruits which enter world trade channels are produced in the irrigated sections of the country while that part of the crop which is sold on the local markets only is grown in the more humid parts of the country.

One of the prominent irrigated sections is the Rio Negro Valley, some 650 to 750 miles southwest of Buenos Aires. The profile of the country is similar in many respects to that of the arid and semi-arid regions in the western part of the United States. Small towns strung out along the valley resemble in appearance this country's frontier villages of 40 or 50 years ago, with their unpaved streets, adobe buildings and the familiar hitching racks for horses. This valley specializes in growing apples and pears. The first commercial orchards were established 20 years ago and in 1928 plantings were undertaken on a large scale. In 1932 the valley shipped 135,000 boxes of apples and 200,000 boxes of pears. By 1939 shipments had increased to well over a million boxes of apples and more than 2 million boxes of pears. On the basis of tree population, acreage and past performance records, it is estimated that by 1945 Rio Negro's annual production will amount to almost 3 million boxes of apples, equivalent to Oregon's yearly crop, and 6½ million boxes of pears, somewhat more than the normal annual production of the State of Washington.

The Mendoza-San Juan region is also irrigated and produces fruit for the world market. It lies along the western boundary of Argentina at the base of the Andean range, the great mountain barrier that divides Argentina and Chile. In this area the Andes tower to some of their greatest heights, culminating in the majestic peaks of Mount Aconcagua and Mount Tupungato, both of which are well over 20,000 feet high. The steep, rugged eastern slopes, badly eroded by wind and rain, are practically nude of vegetation. Eastward from this forbidding barricade, at an elevation of about 2,000 feet, extends the flat country that supports the orchards and vineyards of Mendoza. By nature it is an arid wasteland, but it becomes an oasis when supplied with irrigation water from the melting snow of the slopes that lie above.

Mendoza is known as the vineyard of Argentina and is deserving of all the praise it has received for the quality of its grapes. The province also produces some excellent apples, pears and stone fruits. Grapes and plums from this area are well regarded in both New York and London. San Rafael is the most important tree-fruit area in the region although excellent plums and peaches are produced in the vicinity of the city of Mendoza. The Province of San Juan, north of Mendoza, has a somewhat hotter and drier climate and less diversity of crops. Its cultivated area is devoted almost entirely to grapes; and, while many wine grapes are grown, it is particularly noted for the excellence of its table varieties. There are some tree fruits, mostly apricots, but the industry is not of commercial importance.

Large quantities of deciduous fruits are also grown in the eastern part of Argentina in the province of Buenos Aires and in the delightful Paraná Delta, a group of islands that has been formed by the Paraná and Uruguay Rivers where they join to form the mighty River Plate. A visit to the area is like gliding through the inland waterways of the Florida Everglades or the Louisiana bayous and seeing the banks lined with fruit orchards. Because the delta is surrounded by water, it is free of sudden or extreme changes in temperature, and temperate-zone fruits are produced successfully along with subtropical species. Apples, pears, plums, and persimmons grow side-by-side with oranges and lemons in one happy horticultural family.

The Atlantic region near Buenos Aires is one of the more recently developed fruit areas of the country. Here, in what is primarily grain and cattle country, the orchards are much larger than is common in most parts of the country. While various kinds of fruits are produced, apples are by far the most important.

The varieties of fruit in Argentina are much the same as those grown in the United States, supplemented by varieties which are found in other Southern Hemisphere countries and which have proved popular on the European market.

In case of apples the Delicious is the most heavily planted variety in the country, being more than twice as numerous as the Rome Beauty, the second in importance. Other important varieties are the King David, Stayman Winesap, Jonathan and Gravenstein.

For pears the Williams (Bartlett) is by far the predominating variety and has been heavily planted in Rio Negro and Mendoza districts. The Aremberg (Glo Morceau), Passe Crassane and Anjou are also extensively grown.

The Williams has contributed about 75 percent of the total pear tonnage but recent plantings of late winter varieties are expected to bring about a more equable distribution of production.

Quince production in Argentina is an important industry. About 3 million trees are producing 17,000 short tons annually. While plantings are distributed generally throughout the various fruit-growing regions, the heaviest concentration is in the Delta region. The fruit is produced for the manufacture of quince preserves, or quince paste, a product which vies in popularity with marmalade on the Englishman's table.

The production of stone fruits, particularly peaches, plums, apricots and cherries is rapidly increasing in importance. Peaches rank first in order of importance and exceed the combined number of all other stone fruits.

Grapes are produced in practically all of the fruit-producing districts, but the greatest concentration is in the Cuyo (Mendoza-San Juan) region. Wine is still the leading vine product in this area, but table grapes have become increasingly important, especially for the export trade. Mendoza, which is the center of the wine-grape industry, has 1,325 wineries with an annual capacity of 283 million gallons of wine.

The principal table-grape varieties grown are Emperor, Malaga, Almeria, Ferral, Lattuario and Alphonse Lavalle.

The development of the citrus industry in Argentina is more restricted than that of other fruits because of climatic conditions. The most important area in the country is in the Mesopotamia district, which includes

the Provinces of Entre Ríos and Corrientes and the Territory of Misiones. The second in importance is the Northern district, which includes the Provinces of Tucumán, Salta and Jujuy. The Delta district, close to Buenos Aires, is third.

Oranges have been produced in Argentina for many years, but they have consisted largely of wild-seedling, sweet-orange types. Various attempts have been made to establish a commercial industry but results in many instances have proved unsatisfactory.

The most serious problem confronting the producers of citrus fruits is the question of rootstock. Citrus can be successfully produced in Argentina, provided suitable locations are selected and the proper rootstock is found.

The canning and drying of fruits in Argentina have developed along with the growth of the fresh-fruit industry. Modern, up-to-date canning equipment was imported and the plants are operated on a highly efficient basis. Canned goods are not used very extensively within the country itself; consequently, interest is centered largely in the export field.

Fruit drying is less highly organized than is canning. In some plants operations are conducted under most efficient, highly industrialized and hygienic conditions, whereas in others the process leaves much to be desired. In 1938 the Government issued a decree prescribing rules and regulations to raise the standards of dried fruits. These have met with a certain amount of success, especially where fruit is processed in commercial drying plants. The production of dried fruit in Argentina is around 17,000 short tons.

Cultural practices in Argentina vary according to district and the ideas of the individual grower. On the whole they more or less follow the pattern as laid down in other fruit-growing areas of the world. In some cases the latest and most approved orcharding practices are used, in others the tendency is to follow the line of least resistance. The industry, like that of other countries, is expected to make certain shifts and changes as time and experience points the way.

As a fruit-producing nation, Argentina rose in 5 years from a place of obscurity to one of international importance. The Río Negro and the Mendoza-San Juan districts have taken their place along with such other world-famed regions as the Santa Clara, Hood River, Yakima and Shenandoah Valleys of the United States. They have demonstrated their ability to produce fruit that has made a place for itself on the most discriminating of world markets. When the free way of life is again established in the world, more will be heard from the fruit growers of Argentina.

*Chile.* — After Argentina, Chile is the most important among the South American countries producing deciduous fruits, which grow profusely in the fertile Central Valley, where the country's population and agriculture are concentrated. More than 70 percent of the land surface of Chile is mountainous, much of it standing almost on end. About 40 percent of the country is so parched that even desert plants seem dwarfed and have difficulty in existing. More than a third is wet, damp and cold and sparsely settled. In contrast to the north, where rainfall is next to nothing, the south is extremely wet and has an annual rainfall of 100 inches or more. This area is heavily forested and given over to lumbering, grazing and dairying. The Central Valley, however, frequently spoken of as "the California of South America," is one of the finest agricultural areas in the world. It has a benign climate, without extremes of heat and cold, plus abundant sunshine and water, and is hospitable to practically all the fruits of temperate and subtropical regions.

The commercial fruit industry of Chile is tucked away in small, scattered valleys which make up the Central Valley or the middle third of the country. Fruit plantings extend from La Serena in the north to Puerto Montt in the south, a distance of about 800 miles. The entire district, including some large areas of untillable land, is less than 100,000 square miles in extent.

Practically all fruits common to the Mediterranean region are grown in the northern part of the valley, as well as such stone fruits as apricots, peaches, nectarines, cherries and plums. Apples and pears are also produced but conditions are less favorable than farther south. Grapes and melons are grown to perfection and are recognized everywhere for their excellence.

In general it may be said that the district around La Serena is devoted almost entirely to stone fruits, principally apricots. The district embracing Valparaiso, San Felipe and Los Andes is best adapted for the production of stone fruits, grapes and melons; the district of Santiago for peaches, plums, grapes and pears. Curico is a wine producing district, but plums are rather intensely cultivated and to a lesser extent apples, pears and peaches.

The district around Los Angeles and Angol is the heart of the apple-growing country. Apples constitute about 90 percent of the fruit grown in the area. Some apples are also produced south of Angol but do not enter into the usual distributive channels.

Grapes are the most important crop in the country and the industry has been developed along highly scientific lines. More than twice as much land is given over to grapes as to all other fruits combined. Apples rank second in importance followed by peaches, plums and pears.

In Chile less than half a million acres are devoted to horticultural crops as against 16 million acres in the United States. Tree fruits in Chile occupy about 250,000 acres compared with six million in the United States. Yet horticultural crops represent about 3½ percent of all agricultural crops produced, while in the United States the same crops account for about 4 percent.

Fruit produced in Chile is prepared for both the domestic and export market. Prior to the outbreak of war, emphasis was placed upon the development of overseas outlets, especially Europe. Like most of the other South American countries, Chile is heavily dependent on exports for national prosperity, and before the war fruit exports represented approximately one-tenth of the total shipments of agricultural products. Over 80 percent of the apple exports, which represented around 50 percent of the total crop, were exported to Europe, principally to Germany and France; while substantial quantities of grapes and honeydew melons were sent to the United Kingdom and the United States. While ex-

VARIETIES OF FRUIT IN CHILE, LISTED IN ORDER OF IMPORTANCE

| Apples | Pears | Table Grapes | Plums | Peaches |
|---|---|---|---|---|
| Huidobro | Bartlett | Torontel | D'Agen | Reina Elena |
| Hoover | Angouleme | Cuyana | Santa Rosa | Elberta |
| Delicious | Beurre Quertier | Rosada | Anna Spath | Pomona Mejorado |
| Yellow Newtown | Winter Nelis | Almeria | Climax | Charavisano |
| Jonathan | Comice | Emperor | Wickson | Admirable Amarillo |
| Reinette | Clairgeau | Ribier | Imperial Epineuse | Tardio de Brunel |
| Rome Beauty | Bosc | Sultanina | President | J. H. Hale |
| Northern Spy | Hardy | Malaga Wonder | Sugar | Early Crawford |
| White Winter Pearmain | Anjou | Olivette | | Phillips Cling |
| Winesap | Aremberg | Muscatel | | Decino Zaragoza |
| Ben Davis | P. Barry | | | Pavia de Tonkinson |
| King David | Passe Crassane | | | Champion |
| | Royal d'Hiver | | | Turdivi Brunel |
| | Williams | | | |
| | Easter Beurre | | | |

ports are low in volume, compared to those of Argentina or other large exporting countries, they are important to Chile and any permanent loss of overseas markets will prove to be a serious blow to the country's fruit growers.

While Chile offers an interesting cross section of the fruit kingdom, one of its major problems is not adaptability of species or varieties but rather the selection of those varieties that are most popular on an ever changing world market. While most of the varieties are well and favorably known at home, a number of them are unknown and consequently not in demand on foreign markets. Unlike Argentina, Chile has failed to keep pace with the introduction of new varieties and the change in consumer habits.

While citrus fruits have been produced in Chile for a great many years, production has not been developed to any extent along commercial lines. During recent years some commercial plantings have been established, for the purpose of supplying local markets. Oranges are of first importance followed by lemons. Grapefruit is of no importance, less than 1,000 trees being reported for the whole country. Navel oranges predominate, with the Thompson variety the most important commercially. Washington Navel is second in importance. Valencias are produced on a much smaller scale but production is increasing. Most of the acreage has just reached bearing age.

Olives, avocados and other tropical and subtropical fruits are produced for home use but the volume has not yet reached export proportions.

Cultural practices in Chile vary according to district, individual ideas and the financial condition of the grower. In some cases, orchards and vineyards are operated under the most approved methods while in others there is much room for improvement. The financial situation of many owners is difficult and the rundown condition found on many farms is due to lack of funds rather than to lack of knowledge, carelessness or indifference on the part of the owner.

Chilean wines are recognized everywhere for their excellence and rank with the better known European wines. The utilization of fruit products, however, has not been confined to the vintner since considerable progress has been made in both the canning and drying of fruits. While apples and pears are dried to some extent and raisins are dried in large quantities, special emphasis has been placed upon the preservation of stone fruits, especially peaches, plums and apricots.

A large part of the drying plants are owned and operated by the Government. The plants are not pretentious or operated on so large a scale as some in Argentina, but they are run on an efficient and sanitary basis.

Canning does not compare in importance with certain other important fruit growing countries but it is developing gradually and with quite satisfactory results. The quality of the product is good and while trade has been small the results have been quite satisfactory.

The canning and drying industries in Chile are not expected to develop as rapidly or on the same scale as those in Argentina. The production of fruit is not increasing to the same extent, therefore, the need for processing plants is not so great. Its growth is expected to be gradual and in line with the expansion of the industry itself.

Chile is endowed with many natural advantages, and is in a position to produce fruit capable of withstanding competition on any market. The fruit industry in the light of these advantages could be expanded considerably, although such obstacles as lack of markets and capital and low domestic purchasing power are not easily overcome.

*Brazil.* — The largest, most heavily populated, and one of the least developed of all South American countries is Brazil. It is a land, however, of almost unlimited possibilities in fruit production as in nearly every other type of agriculture. Brazil in land area is larger than the United States and almost three times as large as Argentina. While it lies almost entirely within the tropics, it has quite a wide diversity of climate. A large part of the country is mountainous and made up of vast plateaus, or table lands, which are admirably suited for agricultural purposes. The problem in many parts of Brazil is not to make things grow but to keep one step ahead of the lush wild growth of the jungle Fruits and nuts of all types grow or can be grown in the country, which has the full climatic range from equatorial to temperate.

Brazil produces a wide variety of tropical and subtropical fruits but only a few are exported or known outside of the country. Oranges, pineapples and bananas are produced in surplus quantity and offered for sale on world markets, but such fruits as mangoes, avocados, sapodillas and guavas are consumed only locally. The greatest commercial development has been in citrus fruits, principally oranges.

Temperate Zone fruits can be produced successfully in certain parts of the country, but they have not been developed extensively because the large consuming centers are more or less inaccessible to them. Certain localities in the high plateaus and mountain valleys of the States of Rio de Janeiro, Minas Gerais and São Paulo are adapted to the cultivation of stone and pomaceous fruits. Grapes and other Temperate Zone fruits are grown in the more southern States such as Santa Catarina, Rio Grande do Sul and Paraná.

Quinces are found growing wild in some of the more mountainous sections of southern Brazil and are used extensively in the manufacture of marmalades. In Rio Grande do Sul the raising of apples and grapes has been attempted on a commercial scale. Though the commercial production of grapes has been successful to a certain extent, that of apples has never been. The cultivation of grapes has been confined largely to the labrusca group. The vinifera or European type proved to be unsuited to the moist climate of this region and was discontinued.

The pineapple is produced over a wide territory, with plantations extending from Pernambuco to São Paulo. The most important centers of production named in order of their importance are in the States of São Paulo, Pernambuco, Rio de Janeiro, Minas Gerais and Paraiba, close to the ports or to large consuming centers. The average annual production is around 175 million pounds which is equivalent to around 80 to 90 million fruits, of which about 5 million are exported.

The banana, like the pineapple, is produced throughout the greater part of the country. Commercial production is centered largely in the States of São Paulo, Rio de Janeiro and Minas Gerais and amounts to about 51 million stems. Total production for the country averages about 74 million stems.

Many varieties are produced but only a few enter export channels. Santos and Rio de Janeiro are the chief ports of export. Before the war an active export trade developed between Brazilian and European ports in addition to the trade established with Uruguay and Argentina. Exports for the 5-year period, 1935-39, averaged 11 million stems annually.

Oranges are produced in all parts of Brazil. Commercial development, however, has been restricted to the States of Rio de Janeiro, São Paulo, Minas Gerais, and Baia, with the heaviest production concentrated in Rio de Janeiro and São Paulo. Brazil produces many types and varieties of oranges, but from a commercial standpoint the list is narrowed to two. In the Rio de Janeiro area, which includes the Federal district and the State of Minas Gerais, the Pera, which resembles the Valencia, is the predominating variety; and in the State of São Paulo the Bahia or Navel is by far the most important.

It is estimated that between 75 and 80 percent of the total production of oranges in São Paulo consists of Bahia Navels, whereas Peras account for about 15 percent. Such miscellaneous varieties as Valencia, Natal, Barão, Denia, Pineapple, Hamlin, and Murcia make up the other 5 or 10 percent.

A large part of the Navels produced in São Paulo are too large for the export trade. As a rule only about 50 percent of the oranges meet export-size requirements but in some seasons it is necessary to cull out as high as 70 percent of the crop because of oversized fruit.

Several promising strains of Navels have been introduced which are referred to as Bahianinhas (small Navels). They are good bearers, regular in shape, uniform in size, with invisible navel and of good quality. If the present Navel production were replaced by

these new strains it is believed that they would offer serious competition on the European market during the summer months. The Navel season in São Paulo begins in April and ends in June.

The Pera orange season extends from July to November, which means that the variety is not harvested until after the Navels have been shipped. The Pera is a good producer, has a thin skin and high juice content, which is somewhat thin and watery but very sweet. It is well liked in Europe as well as in Argentina, to which country it is shipped in large quantities. It has a long shipping season and for the country as a whole is considered to be the most valuable variety.

The average annual production of oranges in Brazil is around 35 million boxes, of which under normal conditions about 5 million are exported. Production shows a substantial increase during the past two decades, rising from 2 million boxes in 1921 to over 35 million in 1939. For the 5-year period 1934-38, there was an average increase of more than 9 million boxes over the 3-year average of 1931-33. Practically all of this increase has taken place in São Paulo, Rio de Janeiro and Minas Gerais. Exports are confined almost entirely to the ports of Santos and Rio de Janeiro which are close to the heavy producing centers. Rio de Janeiro is the most important port of export, with average shipments of more than 3 million boxes for the 3-year period, 1937-39. Santos shipped more than 1¾ million boxes during 1937-38 and over 2½ million in 1939. Of a total export movement of 5,631,943 boxes in 1939, Santos and Rio de Janeiro contributed 5,596,495 boxes. Though production in other States is substantial, the fruit is consumed locally.

The cultivation of grapefruit has expanded during recent years. Domestic demand is very limited and consumption negligible; consequently, nearly all of the production is for export, principally to Europe.

Brazil ranks fourth in the world production of lemons. Soil and climate are favorable to the cultivation of this crop but no attempt has been made to standardize varieties or to develop an export trade. The decrease in the production of Verdelli lemons in Italy has stimulated a certain amount of interest in the production of lemons for the European market. Villa Franca, Eureka and Lisbon are adapted to Brazilian conditions. They are productive and are recommended for commercial planting. Lemon production is still in its infancy but authorities believe that it has great possibilities from an industrial standpoint.

The cultural practices of the Brazilian citrus industry can be summed up in a very few words. Brazil is blessed with many natural advantages. Soil and climate for the most part are favorable to the growing of crops. In fact, vegetation of all kinds makes a luxuriant growth without any special assistance. In reply to the question as to what cultural methods are employed, the usual answer is "God's methods." This statement is significant and covers the situation quite adequately. The fruit industry has not developed into the highly scientific business known in the United States and other fruit-growing countries. Its commercial value is readily recognized and its potential possibilities undisputed. The fact remains, however, that the practices usually consist of planting the trees, keeping the upperhand on the ever-encroaching undergrowth, and harvesting and shipping the fruit. The cultural practices in certain instances, however, compare with those of some of the most advanced groves or orchards of the world. In general the attitude is to produce the largest quantity possible with the least effort or expenditure.

OFFICE OF FOREIGN AGRICULTURAL RELATIONS,
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

J. LANJOUW: **On the Location of Botanical Collections from Central and South America:**— The abundant vegetation of Latin America has for centuries attracted plant collectors from all over the world. From their expeditions they brought home large and small collections which greatly enriched herbaria, especially of Europe and North America. Many of these collections have been studied by competent specialists, and other valuable collections have been stored away; at present most of them are in need of revision.

During the last decades there has been an increasing interest in plant taxonomy, especially as it pertains to tropical America. To facilitate the work of taxonomists studying the flora of Central and South America, the following list of collectors has been drawn up. It does not aim at completeness. I am only too well aware that it is very, very incomplete! Most of the important collections will have been included, although several of them will still be missing. My list had to be completed in a relatively short time and under special and difficult circumstances. There will be many mistakes; this could not be avoided, as I have had to rely in most cases on data submitted by others. Sometimes I have been able to correct mistakes, especially in the case of information dealing with collections previously studied by me.

The following sources have been chiefly used:—

1. *Replies to my questionnaires on behalf of the Index Botanicorum* (*cf. infra*!).
2. *The Floras of Central and South America.*
3. *Published catalogues of certain herbaria.*
4. *Biographies of a number of collectors.*
5. *The chapter on the location of botanical collections in* DE CANDOLLE's *'Phytographie.'*
6. *A mimeographed list* made by Dr. H. N. MOLDENKE of C. and S. American collections in connection with his monograph of the *Verbenaceae* and *Avicenniaceae*.*

Some explanatory notes follow.

1. Collectors who have made their collections in different countries may be found under such general headings as West Indies, Central America, and South America, and then again under the individual countries. It was necessary to do this, as it is often stated (in the replies to the *Index Herbariorum* questionnaires, etc.) that the specimens of a certain collector are in this or that herbarium, without mention of the countries where the collection was made.
2. After the collector's name, the year or years in which the collection was made is given between brackets. In several cases I have not been able to ascertain this in the limited time available.
3. For the larger countries the region of the collector's chief activity has often been given between brackets.
4. The symbols used for the herbaria have already been given in my lists in CHRONICA BOTANICA 5:142-150 and 6:377-378. A few additional symbols listed below will be given in a new list, to be published, as soon as circumstances permit, in CHRONICA BOTANICA. In these lists the herbaria are arranged alphabetically according to the names of the towns where they are located; the symbols, therefore, are not always in alphabetical order. An alphabetical list of symbols (abbreviations) will be published in CHRONICA BOTANICA as soon as possible. I might add that the symbols used for this list and the *Index Herbariorum* have in all cases been selected after consultation with the herbaria concerned (*cf.* CHRON., *l.c.*) by an

* This list, which Dr. MOLDENKE kindly placed at my disposal, gives numerous collectors, but no information about the country or region where the collections have been made. Although I could use the list only to complete my own data, I found it very valuable.

official committee of the Int. Botanical Congress and the Int. Union of Biological Sciences.

For the WILLDENOW Herbarium at Berlin the abbreviation B-W and for the separate collections in Genève the abbreviations G-BOIS (= BOISSIER), G-DC (= DE CANDOLLE) and G-DEL (= DELESSERT) are used.

5. In several cases the number of specimens or other important information is given between brackets after the symbol of the herbarium concerned.

6. The notation (*orig.*) after an herbarium symbol indicates that this herbarium possesses the original, first set of a collector. For collections which are in one herbarium only the word has been omitted.

7. In a few cases short notes, which may be of interest, have been added.

Most taxonomists will be surprised to note that there exist so many seemingly important collections about which they have never heard. It is also striking how many important collections have been deposited in small herbaria which as a rule are never consulted by the monographer.

These facts have been a real stimulus for me to continue steadily with the preparation of the *Index Herbariorum*. At first I was somewhat hesitant to prepare the following list for publication under the present circumstances. I yielded, however, to Dr. VERDOORN's request, as the list, incomplete and inaccurate as it is, shows clearly how useful the *Index Herbariorum* may be. This *Index* will, of course, be much more complete and will give many more details about the collections, the regions where they were made, etc.

If one compares the following list with that of DE CANDOLLE's *Phytographie*, which has for years and years been such a valuable source of information for us all, it becomes clear that the *Index Herbariorum* will be much more than a new up-to-date edition of DE CANDOLLE's List, *provided I may continue to have the support of directors and curators of the herbaria of the world. Many detailed replies to my questionnaires on behalf of the Index Herbariorum were received before the war. I should like to state that my collaborators and I continue to work on the index. I hope that the following list, which shows the possible usefulness of the Index Herbariorum, will stimulate those directors and curators who have not yet given me their help. In many parts of the world it will be difficult to continue taxonomic research, as the usual international exchanges are no longer possible. I make an urgent appeal to those who have not yet prepared the necessary data for the Index to do so now.**

BOTANICAL MUSEUM AND HERBARIUM,
UNIVERSITY OF UTRECHT.

* *Editor's Note.* — Dr. LANJOUW's account has been prepared under difficult circumstances, it being the only article in "Plants and Plant Science in Latin America," which we owe to an author living in a country occupied as a result of the present war. As explained already in the Introduction (p. viii) I am especially glad to issue Dr. LANJOUW's account as it shows what an excellent progress he has been making with the Index Herbariorum, a project in which I have always been greatly interested. As Dr. LANJOUW states the following enumeration is incomplete, this is due to the fact that his Committee has not yet received the help of all herbaria of the world. The list shows which herbaria coöperated.

Dr. F. W. PENNELL who kindly read the proofs of this article with me, has made a number of important and useful additions. We have not, however, gone to great efforts to complete Dr. LANJOUW's list, as the following enumeration, the first example showing what Dr. LANJOUW's Committee is preparing for us, should —in my opinion—reflect clearly which large institutions already coöperated and which failed to do so till now.

Dr. LANJOUW's revised, alphabetical list of the symbols used for the herbaria in the Index Herbariorum files has been recently received safely and will soon be published in CHRONICA BOTANICA.

## LIST OF COLLECTORS IN THE WEST INDIES, CENTRAL AMERICA AND SOUTH AMERICA

— West Indies —

**ANDERSON**, A. (1785-1811): C, CGE, G-DEL, K, LE, S. Collected esp. in St. Vincent.
**BALL**, J. (1882): B, K (orig.).
**BEARD**, J. S. (1943- ): A.
**BERTERO**, C. G. (1816-20): B (1100), BO, FI, G-DC, G-DEL, L, M, NY, P, TO, WB.
**BLAUNER**, B. F. (1852-53): G-DC, NY.
**BREDEMEYER**, F. (1784-88): B-W, W.
**BREUTEL**, J. C. (1840-41): B (Hepat.), BM (Bryoph.), BP, BREM, BRSL, L, LZ.
**BRITTON**, N. L.: B (617), NY (very large orig. coll.).
**BRITTON**, N. L. & E. G.: NY (22.687).
**BRITTON**, N. L. & E. G. & J. F. COWELL: NY (7800).
**BRITTON**, N. L. *et al.*: NY (large orig. coll.).
**BROADWAY**, W. E.: A, B, BH, BKL, BM, BP (470), BR, C, E, F, G-BOIS, G-DEL, GH, K, L, LA, LCU, LE, M, MICH, MO, NY, P, PH, POM, S, TRIN, U, UC, UPS, US.
**BROWN**, S., N. L. BRITTON *et al.*: A, B, F, GH, K, LD, NY, PENN, PH, POM, UC, US.
**BROWNE**, P. (1745-55): LINN (orig. coll.), BM. Collected esp. in Jamaica.
**COKER**, W. C.: NY.
**CUMING**, H. (1831): LE, NY, W. Esp. Jamaica.
**CURTISS**, A. H. (1902-04): A, B (500), BKL, BM, C, CU, E, F, G-BOIS, G-DEL, GH, ILL, K, L, LCU, LE, M, MO, ISC, NY, P, PH, POM, PUR, S, SI, TENN, UC, UPS, US, USFS, W, WU.
**DON**, G.: E (orig.), BM, BR, CGE, GOET, LD.
**EARLE**, F. S.: NY.
**EGGERS**, Baron H. F. A. (1870-90, 1899): A, B (7400), BM, BP, BR, BREM, BRSL, C (orig.), DR, F, G, HBG, K (2700), KIEL, GOET, L, LD, LE, LZ, M, MA, MICH, MO, NY, O, P, S, SI, U, UC, US, UPS, W, WU, Z.
**EKMAN**, E. L.: B (large coll.), HAB, K (2080, incl. S. Am.), F, LD, MICH, NY (2021), S, US.
**FISHLOCK**, W. C.: A, GH, K (670), NY, PH, US.
**GRISEBACH**, A.: B, GOET (orig.), K, MO.
**HAMILTON**, W. (1814): P.
**HART**, J. H.: B (c. 2000), F, G-DEL, K (845), L, NY, S, TRIN, US.
**HIORAM**, Brother: HAB, L, NY (608), P.
**HITCHCOCK**, A. S.: B (389), F, GH, ILL, ISC, L, LCU, MO, NY, S, US. The collections consist chiefly of grasses.
**HOUSTOUN**, W. (1729-33): BM, LIN, P.
**ISERT**, P. E. (1787): B-W, C, GH, LZ.
**JACQUIN**, N. J. (1755-59): B-W, BM, W. URBAN states that it is not known where his herbarium is. The specimens in BM are duplicates.
**JARDIN**, E. (1861): BAY, CN, NTM, P.
**KRUG**, L. & I. URBAN: B (their herb.), L, SI.
**KUNTZE**, C. E. O. (1874): B, E, F, G-BOIS, K, MO, NY, US.
**LABILLARDIÈRE**, J. J. H. DE: CGE, FI (orig.), G-DC P.
**LEDRU**, A. P. (1797-98): B, E, FI, MPU, P (orig.).
**MILLSPAUGH**, C. F. (1887-1900): B (c. 200), COLU, F (orig.), GH, NY, WVA.
**MORITZ**, J. W. K. (1834-35): B, BM (orig.), G, GH, L, LE, LZ, NY, O, P, W.
**NICHOLLS**, H. A. A. (1886-91): B (185), K (346).
**OTHMER**: B, L, M.
**PARKER**, C. S.: K.

PLÉE, A. (1820-25): B, P (orig.).
QUESTEL, A.: NY (332).
RAMAGE, G. A. (1888-89): B (600), BM, C. K (795), PH, WU.
READ, J.: B (400), L, PH (orig.).
REHDER, A.: A, B.
RICHARD, L. C. (1786-87): B-W, C, G-DEL, P (orig.).
ROHR, J. (1786): C.
RYAN, J.: BM, C (orig.), F. L. LE, UPS.
SCHOMBURGK, Sir ROBERT (1830-34, 1846-57): B (540), BM, BR, CGE, F, K, L, NY, P, UPS, US, W.
SHAFER, J. A. (1909-12): B (1827), BM, C, F, GH, HABE, K, MO, NY (1273), PH, U, US.
SHERRING, R. V. (1880-90): B, BM, K (4415).
STEHLÉ, H: MICH, NY, (1273), S, U, US. Collected in the French West Indian Islands.
SWARTZ, O. (1784-86): B-W, BM, C, G-DC (600), G-DEL, BR, LD, LE, LINN, M. S (orig.), UPS.
TILDEN, Miss J. E.: K (438 Algae).
TUSSAC, F. R. de (1786-91): FI, G-DC, P (orig.).
UNDERWOOD, L. M.: NY, US.
WAKEFIELD, Miss E. M.: K (425 Fungi & Fil.).
WARMING, J. E. B. (1891-92): BM, C (orig.), F, L, MO, NY, O, P, S, US, W.
WEST, H. (1788-1802): C (orig.), G-DC, L, LE, S.
WIGHT, A. E.: B, F, GH, K, NY, UC.
WRIGHT. W. (1765-98): BM, BR, E (orig.), G-DEL. K, LIV.
WULLSCHLAEGEL, H. R. (1844-49): B (250), BR, DR. GOET, K, M (orig.), W.
WYDLER, H. (1827): B (300), BR, FI, G-DC (orig.), L, NCY, P, W.

— Bahama Islands —

BRACE, L. J. K. (1875-1919): F, K, NY (orig.).
BRITTON, E. G. (1905, 1907): NY.
BRITTON, N. L. (1904): K. NY (158, orig.).
BRITTON, N. L. & L. J. K. BRACE (1904): F, NY (orig. 4000).
BRITTON, N. L. & C. F. MILLSPAUGH (1905, 1907): NY (c. 2000, orig.).
CATESBY, M. (1725-26): BM, OXF.
COKER, W. C. (1903): NY.
FRASER, J. (1802): LINN.
HOWE, M. A. (1904-05, 1907); NY (large coll. of Algae).
HITCHCOCK, A. S. (1890): F (600).
MICHAUX, A. (1789): P.
MILLSPAUGH, C. F. (1904): NY.
MILLSPAUGH, C. F. & Mrs. C. M. (1911): NY.
NASH, G. V. & N. TAYLOR (1904): NY.
NORTHROP, Mrs. A. R. & J. I. (1890): B (487), F (orig.), K (470), NY.
RAWSON, Sir W. (1867-68): B, BM (orig.), K.
ROTHROCK, J. T. (1890): F, NY, PENN (orig.).
SMALL, J. K. & J. J. CARTER (1910): NY.
WIGHT, A. E. (1904): F (282, orig.), GH, K, NY.
WILSON, P. (1907, 1909): NY, F.

— Cuba —

BAKER, C. F. *et al.*: A, B, BM, C, COLU, CU, E. F, G, GH, HAB, ISC, K, L, LE, M, MICH, MO, NY, P, POM, S, U, UC, US, USFS, W.
BOLDO, B. M. (1796-99): MA.
BRITTON, N. L., E. G. & L. H. & J. F. COWELL: B, K, NY (orig. 2500), U, US.
BRITTON, N. L. & E. G., F. S. EARLE & S. C. GAGER: B, (256), NY (3500, orig.), US.
BRITTON, N. L. & E. G., M. A. HOWE & J. A. SHAFER: NY (10500).
BRITTON, N. L. & E. G. & J. A. SHAFER: B, F, HAB, K, MO, NY (2865, orig.), PH, U, US.
BRITTON, N. L. & E. G. & P. WILSON: F, NY (10000, orig.), SI, US.
BRITTON, N. L. & E. G., P. WILSON & F. S. EARLE: F, NY (4000, orig.).
COMBS, R. (1895-96): B (710), F, GH, K, KSA, L, MO, NY (695), US. The original collection in herb. ISC was destroyed by fire in 1900.
CURTISS, A. H. (1904-05): B (233), K (550).
EARLE, F. S. & L. M. UNDERWOOD: L, NY (1930, orig.).
Estación Central Agronómica de Cuba: NY (726).
GREENE, B. D.: B, BSN, K.
GUNDLACH, J.: B (43), LZ.
HITCHCOCK, A. S. (1906): US.
HOWARD, R. A. (1941): F, GH (orig.), MO, MT, NY, UC, US.
HUMBOLDT, F. W. H. A. & A. BONPLAND (1800-01): B-W, L, P (orig.).
JACK, J. G.: A, B, BH, BM, C, F, G-DEL, HAB, K (565), L, MICH, NY (536), P, POM, S, UPS, US.
JAEGER, B.: BP.
LEIBOLD, F. E. (1839): HAL, KIEL (orig.). LZ, PR.
LEÓN, Brother *et al.*: B, BR, F, HAB, K, L, NY, P, U, US, Y.
LINDEN, J. J. (1837-38, 1844): B (300), BR, CGE, FI, G, GENT (orig.), L, LZ, P.
MURRILL, W. A. & F. S. EARLE: NY (2537 Fungi).
OTTO, C. F. E. (1839): B (364), BR, C, E, K, L, LE, W.
PALMER, E. & W., & C. L. POLLARD: NY (414).
POEPPIG, E. F. (1822-24): B, BM, G, GOET, K, KIEL, L, LE, LZ, P, W.
PRINGLE, C. G.: B (70), NY.
RICHARD, L. C. M.: CGE, P.
RUGEL, F. (1849): B (300), K (352).
SAGRA, RAMON DE LA (1823-35): B (c. 1000), BM (110), F, FI, G, K, LE, LUB, NY, P, W, Z.
SAUVALLE, F. A. (1824-79): HAB.
SHAFER, J. A. & LEÓN: NY, HAB, U.
TORRALBAS, J. I. (1890-91): B (360).
WILSON, P. & LEÓN: F, HAB, L, NY, U, US.
WRIGHT, C. (1856-67): B (c. 3000), BM, BP, BR, CGE, BUF, FH, G, GH (c. 4000, orig.), GOET, HAB, K, L, LE, MA, NY, P, TCD, W, WB.

— Caiman Island —

FAWCETT, W. (1888): BM, K.

— Jamaica —

ALEXANDER, R. C. *vide* PRIOR.
BANCROFT, E. N. (1826-42): K.
BRITTON, E. G.: K (205 Musci).
BRITTON, N. L.: B, K, NY (orig.).
BROWN, ROB.: MW.
BROUGHTON, A. (1783-96): BRIST.
COCKERELL, T. D. A.: K.
CRUEGER, H.: B, K, NY, TRIN, US.
DISTIN, H.: (1830-40): K.
FAWCETT, W. (1887-1908): B (c. 5000), BM, C, F, G-BOIS, GH, JAM (orig.), K, NY (5230), US.
HARRIS, W. (1881-1913): A, B (643), BG, BM, C, F, G, GH, HAB, JAM (orig.), K, L, MO, NY, O, P, PH, S, SI, UPS, US, W.
HARTWEG, TH.: LD (orig.), CGE, K.
HITCHCOCK, A. S. (1912): US.
HOUSTOUN, W. (1729-33): BM.
JENMAN, G. S. (1873-79): K.
MACFADYEN, J. (1825-50): GOET, K (orig.), U.
MCNAB, G. (1838-59): B (100), BM, E, GOET, K, L, OXF, U.
MARCH, W. T. (1857-58): B (250), GH, GOET, K, L, LE, NY.
MASSON, F. (1781): BM.
MORRIS, Sir DANIEL (1879-86): JAM.
MURRAY (1827): B, FI, G-DC.
ORCUTT, C. R.: BM, COLU, F, ISC, K (660), MICH, MO, NY, POM, SD, UC, US.
PITT, Mrs. W. R.: NY (615, Algae et Filic.).
PRIOR, R. C. A. (1849-50): B, CGE, GOET, K. Originally his name was R. C. ALEXANDER. In 1849, after the death of a near relation, he added the name "Prior" to his own one. Perhaps duplicates of his Jamaica plants are in some other herbaria.
PURDIE, W. (1843-44): K.
RUSSELL, H. W. (1906): K (634 Filic.).
SHAKESPEARE, R. (1780-82): BM.
SLOANE, H. (1687-89): BM.
SYME, G. (1879-84): K, O.
WILSON, N. (1857-58): B (250), BM, GOET, K (orig.).
WRIGHT, W. (1771-85): BM (orig.), BR, E, G-DEL, K.

— Haiti —

AUBLET, J. B. C. F.: MPU. According to URBAN plants of AUBLET from Haiti are in Montpellier. There are certainly also plants from Haiti in the herbarium of DEMAIFFE at Carignan. *See also* under French Guiana.

BUCH, W. (1898-1910): B (1127), NY, L, S.
CHRIST, E. (1899-1910): B (630), L.
EHRENBERG, C. A. (1828-31): A, B (600), BM, C, HAL, K, L, LE, MO, NY, P, S, U.
JAEGER, B. (1827-28): B (210), LE (orig.), OXF, U.
LEONARD, G. M. & E. C. (1928): BH, BKL, GH, K (740), MICH, MO, NY, UC, US.
NASH, G. V. & N. TAYLOR (1905): B (293), F, MO, NY, US.
POITEAU, A. (1796-1801): B (c. 400), FI, G, L, LE, P (orig.).
SCHUMANN, W. (1884): B, L.
TÜRCKHEIM, H. VON: NY.

— San Domingo (Dominican Republic) —

FUERTES, M. (1910-12): B (2149), BM, C, E, F, G-DEL, GH, K (755), L, LE, LD, M, MO, NY, O, P, S, SI, U, US, W.
MAYERHOFF, C. J. (1856-59): B (868), L.
POITEAU, A. (1800-01): FI, G-DEL, P (orig.).
PRENLELOUP, L. A. (1853-69): B, G-BOIS, LAU (1054, orig.), NY, US.
TAYLOR, N.: B (335), BKL, F, NY.
TÜRCKHEIM, H. VON (1909-10): B (1254), BP (1300), K (580), L.

— Puerto Rico (and Virgin Islands) —

BRITTON, E. G.: NY.
BRITTON, N. L. & E. G. & K. R. BOYNTON: NY (600, orig.), US.
COWLES, H. T.: G-DEL, ILL, NY (4100), US.
GROSOURDY, R. DE: P.
HAGELSTEIN, R.: NY (Algae).
HELLER, A. (1899-1900): A, ARIZ, B, BRU, COLU, CU, E, F, G-BOIS, G-DEL, GH, HABE, ILL, ISC, K, L, LA, LE, MICH, MO, NY, PENN, PH, POM, S, U, US.
HOWE, M. A.: NY (Algae).
KRUG, L. (1875-76): B (1554).
NORDAL WILLE, J. N. F.: NY (8000 fresh-water algae).
PLÉE, A. (1822-23): B, L, P.
SCHWANECKE, C. (1846-49): B (322), BM (Bryoph.), GOET, LZ, W.
SINTENIS, P. E. E. (1884-87): B (8450, orig.), BG, BM, (2499), BP, BR, BRSL, BREM, CAL, COLU, E, F, G, GH, GOET, GRO, HAB, HBG, HT, ISC, JAM, K, L, LAU, LD (orig.), LE, LUB, M, MIN, MO, NY, O, P, PH, POM, PR, S, TRIN, SI, U, UPS, US, W, WU, Z.
STAHL, A. (1865-89): B (1144), BG, L, GOET, S.
WYDLER, H. (1827): FI, G-DEL, G-DC (orig.), L, LZ, NCY.

— St. Thomas —

BØRGESEN, F. C. E. (1892, 1895-96): BG, C (orig.), F, M, O, UPS.
DUCHASSAING, P. (1844-52): B, GH, GOET, K, LE, MO, NY, P (orig.), W.
EHRENBERG, C. A. (1827-28): B (400), HAL, KIEL, L.
GOLLMER, J.: B (orig.), L.
KNEBEL: KIEL.
PETERSEN, L.: B, KIEL.
RAVN, P. (1819-39): B, C (orig.), KIEL, S.
WYDLER, H. (1827): FI, G-DC (orig.), G-DEL, L.

— St. Croix —

BENZON, P. E. (1817-48): C (orig.), S.
RAVN, P. (1819-39): B, C (orig.), KIEL, S.
RICKSECKER, A. E. & Mrs. J. J. (1895-97): B (c. 800), E, F (orig.), GH, ILL, L, MIN, MO, NY, O, OC, P, POM, UC, US.

— St. John —

BØRGESEN, F. C. E.: C.
KNEVELS: KIEL.
RAVN, P. (1819-39): C.

— St. Kitts —

BRITTON, N. L. & J. F. COWELL (1901): B (334), K (212), NY (orig.).

— Antigua —

UHLES: KIEL.
WULLSCHLÄGEL, H. B.: BR, GOET, M.

— Guadeloupe —

ALLORGE, P. & V. (1936): P.
BEAUPERTUIS (1839): B, P (orig.).
BERTERO, C. (1816-18): B, L, MPU, P, TO.
BUCQUET (1877): P.
DUCHASSAING, P. (1844-48, 1851-52): (835), GOET, P.
DUSS, Père A. (1891-1924): B (4500 incl. Martinique), NY, P, US.
FELDMANN, J. (1936): P.
FUNCK, N. (1845): BR, GENT, K, LZ, OXF, P.
HUSNOT, T. (1868): B, BM, BR, G-DC, K, L, P.
ISERT, P. E. (1787): B, C, LZ.
JARDIN, E. (1861): BAY, CN, P.
L'HERMINIER, F. L. (1798-1829): B (250), BM, G, L, P.
L'HERMINIER, Fr. (1830-66): B, G, Musée L'Herminier à Pointe-à-Pitre, P, W.
MAZÉ, H. P. (1851-92): B (964), BM, Mus. L'Herm., LD, K (1982), P. Coll. of marine algae and Filic.
NYST, P. (1830): BR (c. 800).
PERROTTET, G. S. (1824 & 1841): B, BM, G, L, MPU, P.
PLÉE, A. (1820): B, P.
PURDIE, W. (1857): B, GOET, K, P.
QUENTIN, R. P. (1926-38): P, Herb. Stehlé.
READ, J.: B, PH.
RICHARD, L. C. (1786-87): B, C, P.
RODRIGUEZ, L. (1934, 1936): P.
ROHR, J. VON (1786): B, BM, BR, C.
SCHLIM, L. J. (1845): BR, FI, G, K, P.
STEHLÉ, H. & M. (1934-38): NY, P, U, US.
THIÉBAUT (1878): P.

— La Désirade —

DUCHASSAING, DUSS, QUENTIN, RODRIGUEZ and STEHLÉ. *See under* Guadeloupe.

— Marie-Galante —

BUCQUET (1877): B, LE, P.
DUSS, HUSNOT, QUENTIN, RODRIGUEZ and STEHLÉ. *See under* Guadeloupe.

— Les Saintes —

DUSS, QUENTIN, RODRIGUEZ and STEHLÉ. *See under* Guadeloupe.

— St. Barthélemy —

EUPHRASEN, B. A. (1788): UPS.
F. L. L'HERMINIER, PLÉE, and QUENTIN. *See under* Guadeloupe.

— St. Martin —

BOLDINGH, I. (1906): U.
SURINGAR, W. F. R. (1885): B, L (orig.).
WALCH, J. J. (1889): K.
WENT, F. A. F. C. (1902): U.

— St. Eustatius —

GROL-MEYERS, J. VAN (1904-06): U, Kol. Inst. Amsterdam.
BOLDINGH, SURINGAR, WALCH and WENT. *See under* St. Martin.

— Saba —

LIONARONS, A. C. W. (1907): Kol. Inst. Amsterdam.
BOLDINGH, SURINGAR and WENT. *See under* St. Martin.

— Martinique —

BÉLANGER, C. (1853-81): B, FI, G, LE, P.
DUSS, Père A. (1876-89, 1899-1901): B, F, LE, NY (3404 incl. Guadel.), MO, P.
GOUDOT: FI.
HAHN, L. (1867-70): B (1200), BM (988), BP, BR, F, FR, G, GH, K, L, LE, LG, LUB, M, NY, P (orig.), PH, S, UPS, W, Z.
HUSNOT, T. (1868): B, BM, BR, G-DC, K, L, P.
ISERT, P. E. (1787): B, C, LZ.
JACQUIN, N. J. (1755): B, BM.
JARDIN, E. (1861): BAY, CN, P.
LEBLOND, J. B. (1767): P.
MARTIN, J. (1789): B, FI, P.
PERROTET, G. S. (1841): B, G, MPU, P.
PLÉE, A. (1820, 1825): B, P.
PRIVAULT, D. (1936): P.

QUENTIN, R. P. L. (1931): P.
RICHARD, L. C. (1786-87): B, C, P.
RIVOIRE, Mme. (1839): P, FI.
RODRIGUEZ, L. (1934): P.
SIEBER, F. W. (1819-21): BM, K, KIEL, P, U.
SMITH, H. H. & G. W. (1889-90): B, K.
STEHLÉ, H. & M. (1936-37): NY, P, US and Herb. Stehlé.
STEINHEIL, A. (1839): B, P.
SURIAN, J. D. (1689-91): P.
TUSSAC, F. R. DE (1786): FI, G-DC, P.
WEST, H. (1795): B, C (orig.), G-DC.

— Dominica —

DUSS, Père A. (1883, 1885): B (250, incl. St. Lucia).
HODGE, W.: GH.
IMRAY, J. (1837-80): B (250), GH, GOET, K (orig.). LE.
VALEUR, E. J.: A, B, C, F, G-DEL, K (580), LA, LCU, MICH, MO, NY, POM, S, UC, US.

— St. Lucia —

DUSS, Père A. (1885): B, P.
PLÉE, A. (1821): B, L, P.

— St. Vincent —

SMITH, H. H. & G. W. (1889-90): B, BM (635), K.

— Barbados —

BOVELL, I. R. & W. G. FREEMAN: F, GH, NY, US.
BRITTON, E. G.: NY.
DASH, J. S.: F, NY, US.
HOWARD, A.: Herbarium G. S. West (Algae).
WABY, J. F. (1895): B (135), K (136), L, US.

— Trinidad and Tobago —

BRITTON, E. G.: NY.
BRITTON, N. L. & E. G. (1920-21): COLU, F, GH, NY (orig.), TRIN, US.
BRITTON, N. L. & E. G., D. COHEN & T. E. HAZEN: NY (6000).
BRITTON, N. L. & E. G., T. E. HAZEN & F. J. SEAVER (1920-21): K (270), NY (orig.).
BRITTON, FREEMAN & WATS: GH, K, NY, TRIN, US.
BROADWAY, W. E. (1909-33): A, B (2387), BH, BKL, BM, BR, C, E, F, G, GH, K(3000), L, LA, LCU, LE, M, MICH, MO, NY, P, PH, POM, S, TRIN, U, UC, UPS, US.
BROMFIELD, W. A. (1844): K.
CHEESMAN, E. E. (1925-37): K (3000), BM.
COPELAND, R.: K.
CRUEGER, H. (1841-64): B (Hepat.), GOET, K, KIEL, NY, TRIN, US, WB.
Dept. of Agriculture (1924-33): K (920), TRIN.
FENDLER, A. (1877-83): BM (Filic.), BUF, E, F, G-DEL, GH, K (1000), LE, MO, NY, NYP, P, PH, US, WELC.
HITCHCOCK, A. S. (1912): US.
HOWARD, A.: Herbarium G.S. West (Algae).
LOCKHART, D. (1818-46): BM, K, NY, P.
PURDIE, W. (1841-57): B, FI, GH, K, L, NY, P, U, COLU.
SANDWITH, N. Y. (1937): K (326), U.
SIEBER, F. W. (1822): B (380), K, KIEL, L, LZ, U. SIEBER's plants were collected by others. He never visited the W. Indies. The plants were distributed as "Flora Martin.," "Flora mixta" and "Flora Trinitatis."
WILLIAMS, R. O. & W. G. FREEMAN (1927): K, NY, POM, TRIN (orig.).

— Margarita Island —

JOHNSTON, J. R. (1901-03): B (269), C, F, G-BOIS, GH, K (162), LE, M, NY, UC, US, W, WU.
JOHNSTON, J. R. & O. O. MILLER (1911): B (270), BM (266), C, F, G-BOIS, GH, K, LE, MO, NY (261), P, POM, UC, US, W.

— Curaçao —

ASCHENBERG: U.
BOLDINGH, I. (1909-10): B, C, K, L, NY, P, U (orig.).
BREDEMEYER, F. (1787): B, W.
BRITTON, N. L. & J. A. SHAFER (1913): K, NY (orig.), U, US.
KILLIP, E. P. & A. C. SMITH (1927): A, GH, NY, US.
READ, J.: B, PH.
ROHR, J. P. B. VON (1786) C.
SURINGAR, W. F. R. (1885): B, L (orig.).
VERSLUYS, W. (1907): U (esp. *Gram.*).
WENT, F. A. F. C. (1901): U.
WAGENAAR HUMMELINCK, P. (1930, 1936-37): U (esp. *Agave* and *Cactac.*).

— Aruba —

BOLDINGH, SURINGAR, WAGENAAR HUMMELINCK. *See under* Curaçao.

— Bonaire —

BOLDINGH, SURINGAR, WAGENAAR HUMMELINCK. *See under* Curaçao.

— Mexico —

ANDRIEUX, G. (1835): FI, G-DC, G-DEL, K, M, P (orig.), U, W.
APOLLINAIRE: L, US.
BASSI: FI.
BERLANDIER, J. L. (1827-30): B, BM (1300), BP, COLU, F, FI, G, GH, K, KIEL, LD, LE, LZ, MO, NY, P, PH, S, W.
BONPLAND, A.: CGE.
BOTTERI, M.: A, AWH, B, BM, C, CGE, F, G-BOIS, G-DC (648), G-DEL, GH, K (1000, orig.), L, MO, NY, P, PH, US.
BOURGEAU, E.: (1865-66): B (1036), BM, BR, C, COLU, F, FI, G, GH, K, L, LE, M, NY, P (orig.), S, UC, US, W.
BRANDEGEE, T. S. (1892-1904): A, GH, L, NY, POM. UC, US.
BUKASOV, S. M.: WIR.
CONZATTI, C.: B (66), F, K (40), MICH (269), NY (923).
COULTER, T. (1833): TCD.
EDWARDS, MARY T. (MULLER) (1937): F, TEX (2500).
EHRENBERG, C. A. (1831-40): B (2000), BM, C, G-BOIS, HAL, K, L, LE, MO, NY, S.
ENDLICH, R. (1903-07): B (2031), L.
ERVENDBERG, L. C. (1858-59): GH.
FINCK, H. (1865-94): K (1464).
FISHER, G. L.: F, G-DEL, ILL, LCU, MO, NY (438), US, W.
GALEOTTI, H. (1835-40): B, BR, E, F, G-BOIS, G-DEL, GENT, GH, K, L, LE, LG, LV (orig.), NY, P, U, UC, US, W.
GANDER, F. F.: SD (large coll.).
GAUMER, G. F.: A, B (1831), BM, BR, C, E, F, G, GH, K (1170), LCU, LD, LE, MA, MICH (360), MO, NY, P, PH, POM, S, UC, UPS, US, W.
GENTRY, H. S.: F, K (960), LA, LCU, MICH, MO, NY, PH.
GHIESBREGHT, A. (1838): BM (384) BUF, G-DEL, K, L, LE, NY, P.
GOUIN: NY, P.
GRAHAM, G. J. (1830): K.
GREGG, J. (1848): BG.
HAENKE, T. (c. 1790): BM, F, K (some *Cyperaceae*), KIEL, M (700), NY, PR (orig.), PRC, W.
HAHN, L. (1865-66): B, BM, BR, F, G, GH, K, L, LE, M, NY, P, PH, S, UC, UPS, US, W.
HARTWEG, TH. (1836-39): B, BM, CGE, FI, G, GH, K, L, LD (2200 incl. Colombia and Calif., orig.), NY, P, U, W.
HINTON, G. B. (1932-37): A, F, GH, K (10000, orig.), LA, MA, MICH, NY (2457), U.
HITCHCOCK, A. S. (1910): US.
HOUSTOUN, W. (1730-31): BM, P.
HUMBOLDT, A. & A. BONPLAND (1803-04): B, P.
JOHNSON, E. P.: K.
JOHNSTON, I. M.: GH.
KARWINSKY, Baron W. F. VON (1827-32, 1840-43): BR, FI, G-DEL, KIEL, LE (2000, orig.), M, MW, NY, U, W.
KERBER, E. (1878-83): B (675), BM (689), BP, BR, C, G, K (200), KIEL, LE, LG, M, NY, UPS, US.
LAMBERT: FI.
LANGLASSÉ, E. (1898-99): B (1100), K (1000, incl. Colombia).
LANGMAN, I. K. (1939-40): PH.
LAY, G. T. & A. COLLIE (1827-28): K.

LE SUEUR, H. (1935-38): —Chihuahua— F, TEX (4000, orig.).
LIEBMANN, F. M. (1841-43): B, C (orig.), F, G-DC, K (943), L, LA, NY, U, UC, US.
LINDEN, J. J. & N. FUNCK (1838-41): GENT.
LUMHOLTZ, C. (1894): K (547), US.
LUNDELL, C. L. (1931-37): -Yucatan Penins.- A, B, C, DPU, GH, K, LA, LCU, MICH (5337), MO, NY, S, TEX (1000), UC, US. -San Luis Potosi- MICH (700).
MARSH, E. G. (1934-37): TEX (3500).
MARTINEZ, M.: MEX.
MATUDA, E. (1936-37): -Chiapas, Vera Cruz- DPU, F, MICH (2373), NY.
MEXIA, YNES (1925-29): A, B, BM, C, CAS, F, G-DEL, GH, L, LA, MICH (940), MO, NY, P, PH, POM, S, U, UC, US, USFS.
MILLSPAUGH, C. F. (1887-99): F (orig.).
MOCIÑO, J. M. (1795-1804): *See under* SESSÉ.
MORTON, C. V.: -Oaxaca- MICH (123).
MÜLLER, F. (1853): K.
MULLER, C. H. & MARY T. (EDWARDS) (1935): A, F, ILL, L, MICH, NY, TEX (600).
NÉE, L. (1791): MA.
ORCUTT, C. R.: K (855), NY.
ORTEGA, J. G.: ISC, K (1400), NY, POM.
PALMER, E. (1886-1910): A, B (1700), BM, BPI (Fungi), C, COLU, E, F, G, GH, K (2000), L, LE, MICH (349), MO, NY, P, PH, POM, PRI, S, SD, U, UC, UPS, US, W.
PARRY, C. C. & J. M. BIGELOW *et al.*: GH, ISC (orig.), K (550), L, US.
PARRY, C. C. & E. PALMER (1879): B, BM, COLU, E, F, GH, ISC (orig.), K (294), MO, PH, US.
PENNELL, F. W. (1934-35): PH.
PRESL, K. B.: BM (Reliq. Haenkeanae), KIEL, PRC (5000, Filic.).
PRINGLE, C. G. (1888-1906): A, B (7560), BKL (2000), BM (3435), BP, BR, BRSL (3100), BRU, C, CAS, COLU, CU, E (300), F, FH, G-BOIS, G-DEL, GH, HAB, ISC, K (3365), L, LA, LCU, LE, M, MA, MICH, MO, NY, O, P, PH, POM, S, SI, UC, UPS, US, W, WELC (*Lotus*), WU.
PURPUS, C. A. (1928-31): A, ARIZ, B, BKL, BM, C, E, F, G-DEL, GH, K, L, LE, M, MICH (330), MO, NY, P, POM, S, UC, US, W.
QUARLES VAN UFFORD, L. H. (1910-11): U.
ROSE, J. N. (1891-94): A, F, GH, K, LA, NY, UPS, US.
ROSE, J. N., J. H. PAINTER & J. S. ROSE: F, GH, NY, U, US.
ROVIROSA, J. N. (1890-91): B (42), COLU, K (650), PH, US, UC.
ROZYNSKI, H. W. VON (1932): F, G-DEL, MICH (233), NY (670), US.
RUTTEN, L. & C. RUTTEN-PEKELHARING (1921): U.
SALLÉ, C.: B, BM (1143), G, K, W.
SARTORIUS, K.: US.
SCHAFFNER, J. G. W. (1875-79): -San Luis Potosi- B (1239), BM (483), BRSL (600), COLU, GH, K (1204), KIEL, M, MICH (220), NY, P, W.
SCHEFFER: FI.
SCHENCK, J. H. R. (1908): B (404).
SCHIEDE, C. J. W. & F. DEPPE (1828): B (1578, orig.), BM, CGE, G-DEL, HAL, K, KIEL, LE, LZ, MO, NY, U, US, W.
SCHOTT, A. C. V.: BM, F, G-DEL, L, ILL, MO, NY, US, W (*Arac.*).
SCHULTZE, L.: B (516).
SCHUMANN, W. (1884-88): B (492), BM (208), C, L, LE, M, US, W, WU.
SEEMANN, B. C. (1849-50): K. Voyage of H. M. S. "Herald."
SELER, C. & E. (1887-88, 1895-97, 1902-07, 1910-11): B (5796, incl. Centr. & S. America).
SESSÉ, M., J. M. MOCIÑO & V. CERVANTES (1795-1804): F, G-DEL, K, MA (4000, orig.), NY.
SINCLAIR, A.: K.
STANDLEY, P. C.: US.
STEERE, W. C. (1932): F, LA, LCU, MICH (1400), MO, NY, S.
SWALLEN, J. R. (1932): -Yucatan Penins.- MICH (300), US.
TATE, R.: CGE, NY, US.
TOWNSEND, C. H. T. & C. M. BARBER (1899): B (418), E, F, G, GH, K (425), MO, NY, P, POM, US.
UNDERWOOD, L. M.: NY.
VIERECK, H.: B (797, orig.), US.
WHITING, A. F. (1934): MICH (270).
WIGGINS, I. L.: DS.
WILLIAMS, L. (1937): F, U.
WISLIZENUS, A. (1846-7): BG.
WOOTON, E. O.: BM (428), ARIZ, ILL, IND, NY (1111), POM, US, WVA.
WRIGHT, C. (1847-48): FI, G-DC, L.
WYND, F. L.: NY.
WYND, F. L. & C. H. MULLER: LIL, K (565), LCU, MO, NY, S.

— Central America —

BARCLAY, G. W. (1836-41): BM, K, NY, U. Collections made during the voyage of H. M. S. Sulphur, 1836-41.
BARTLETT, H. H. (1931): A, F, ILL, K, LCU, MICH (900), MO, NY, POM, US.
BONPLAND, A. J. J.: B, F, L, NY, P (orig.).
FRIEDRICHSTHAL, E. Ritter VON (1841): G, K, W (orig.).
GENTLE, P. H.: DPU, F, K, LCU, MICH, MO, NY, S, US.
HINDS, R. B. & G. BARCLAY (1836-39): K.
HITCHCOCK, A. S. (1911): US.
LANGLASSÉ, E.: B, G-DEL, GH, K, NY, P, US.
MATUDA, E. (& P. H. GENTLE & C. L. LUNDELL): DPU, F, MICH, NY. Esp. Mexico.
NÉE, L. (1789-94): C, MA (orig.).
NIEDERLEIN, G.: NY, B (459).
ØRSTED, A. S. (1846-48): B, C (orig.), BM (Musci), F, NY, US.
SEIBERT, R. J.: K (380), MO, NY. Esp. Panama-region.
SMITH, J. D. (1900-06): B, COLU, G-DEL, GH, K, L, M, NY, P, US (orig.).
TONDUZ, A.: NY.
WARSCEWICZ, J. VON (1848): B, G-BOIS, KRA, U.

— Guatemala —

AGUILAR, M. (1933-34): A, F, LCU, MICH (430), MO, NY.
BERNOULLI, G. (& RICH. CARIO): B, BR, COLU, FI, G-DC, K (orig.), S.
BUKASOV, S. M.: WIR.
COBAN: BP.
DEAM, C. C.: A, E, F, GH, ILL, IND, L, MICH, MO, NY, PUR, US, WVA, and in private herb. of C. C. DEAM, Bloomington, Ind.
HARTWEG, TH. (1839): B, FI, K, L, LD (orig.).
LUNDELL, C. L. (& P. H. GENTLE): K (750, incl. Brit. Honduras).
MORTON, F. (1928-29): B, HALLST (400, orig.).
SALVIN, O. & F. DU CANE GODMAN (1857-74): B (71), K (412), W.
SCHIPP, W. A.: NY.
SKINNER, G. U.: K.
SKUTCH, A. T. (1933): A, F, MICH (230), MO, NY, S, US.
SMITH, J. D. (1889-99): B (3309), BM (670), COLU, G-DEL, GH, K (3226), L, M, NY, P, US (orig.).
STANDLEY, P. C.: F.
STEYERMARK, J. A. (1940): F.
TONDUZ, A.: B.
TÜRCKHEIM, H. VON (1877-1908): A, B, BM, BP (800), BR, BRSL (800), COLU, E, F, G-DEL, GH, ILL, ISC, K (768), L, M, MICH (125), MO, NY, P, S, SI (350), U, US, W, WU.
VELASQUEZ, J.: BO.

— British Honduras —

CHANEK, M. (1933): F, MICH (225), NY.
GENTLE, P. H. (1933-37): DPU, F, K, LCU, MICH (1464), MO, NY, S, US.
LUNDELL, C. L. (& P. H. GENTLE): K.
MAINS, E. B. (1936): MICH (389, *Uredinales*).
O'NEILL, H. (1936): BH, FLA, ILL, LCU (1733), MICH, (217), MO, NY, POM, US.
PECK, M. E. (1907): B, F, GH (800), K, ISC, NY, U.
SCHIPP, W. A. (1929-36): A, B, BKL, BM, F, G-DEL, GH, K (1560), L, LCU, MICH (1357), MO, NY, S, UC, US.

— Honduras —

CHICKERING, A. M. (1930): F, MICH (230).
EDWARDS, J. B.: A, B, F, K (270), NY, P, S, UC, US.
GAUMER, G. F. (1885): B (275), K (544), L.
MITCHELL, E. O. (1875-77): K.
MITCHELL, Mrs. E. R. (1926): F, GH (orig.), US.
STANDLEY, P. C. (1927-28): A, F (3000), US.
TEMPLE, R. (1856-65): K.
WILSON, P. (1903): A, B, F, K, MO, NY, POM, US.
YUNCKER, T. G. *et al.* (1934-36): DPU, K (660), (884), NY (800), U.

— Salvador —

CALDERÓN: BM, F, GH, K, NY (215), S, US.
SCHULTZE, L.: B (236).
STANDLEY, P. C.: F.

— Nicaragua —

GARNIER, A.: MGA (c. 4000, orig.), MICH, NY, US.
LÉVY, P. (1872): C, G, K, LG, NY, P.
ØRSTED, A. S. (1846-48): B, C (orig.), CGE, F, US.
ROTHSCHUH, E. (1893-95): B (650), L.
SEEMANN, B. C.: BM (338), K.
TATE, R. (1868-84): K, BM (269), US.

— Costa Rica —

BRADE, A. C.: B.
BRENES, A. M.: CR (20000, orig.), F, K, NY.
BRIGGS, T. (1829-45): K.
COOPER, J. J. (1886): B, COLU, GH, K (300, Filic.), MICH, NY, US.
CUFODONTIS, G. (1930): B, GE (200), W.
DANIELSON, K.: MICH (138, Fungi & Lich.).
DURAND, T. & H. F. PITTIER: BM (1180), L.
ENDRES, E. (1875-84): K (541), W.
HOFFMANN, C. (1854-59): B (928, orig.), BM, K, U.
HOWELL, J. T.: CAS (orig.), F, LA, NY, POM.
JIMÉNEZ, O.: CR (orig.), US.
LANKESTER, C. H. (1919-20): F, K (400), L, NY, US.
ØRSTED, A. S. (1846-48): C.
PITTIER, H.: B (1030), CR (orig.), F, NY, US. He and others founded the National Museum in San José.
SKUTCH, A. F. (1936): F, K (1090), MICH (443), MO, NY, S, US.
SMITH, J. D.: US.
STANDLEY, P. C. (1923-26): F (15000), US.
STEWART, A.: CAS (orig.), F, GH, MO, NY, US.
STORK, H. E. & K. DANIELSON (1928): MICH (260).
TONDUZ, A.: B, BM (878), K (690).
TONDUZ, A. & H. F. PITTIER (1899 *et seq.*): B, CR (orig.), K (550), L.
VALERIO: F, L, MVH.
WENDLAND, H. (1856-57): C, K, US.

— Panama —

ALLEN, P.: MO.
AMES: L.
BILLBERG, J. E. (1825-26): B, NY, S (orig.), US.
CHICKERING, A. M. (1928): MICH.
COOPER, G. P.: F, K (256), MICH, NY, P, S, US.
DUCHASSAING, P. D. (1849-51): GOET.
FENDLER, A. (1850): K, US.
HALSTED: K.
HART, J. H. (1885): K, US.
HAYES, S. (1860-63): BM (1320), CGE, COLU, GH, K, NY.
KILLIP, E. P. (1917-18, 1922): US.
MAXON, W. R. (1911, 1923): US.
PAUL (1934): COLU, F, MICH, NY, U, US.
PIPER, C. V. (1923): US (1000). This collection was made in ten days!
PITTIER, H. F. (1911, 1914-15): B (208), US (4175).
POWELL, C. W. (1907-27): MO (esp. *Orchidac.*).
SEEMANN, B. C. (1846-49): BM, GH, K.
SEIBERT, R. J.: MO, NY (263).
STANDLEY, P. C.: US.
WILLIAMS, R. S. (1908): BM, K, NY, US.
WOODSON, R. E.: MO.

— South America —

BAENITZ, C.: CGE.
BALL, J. (1882): B, COLU, K (orig.).
BERTERO, C. G.: NY, L.
BETTFREUND, C.: B (720).
BONPLAND, A. J. J.: B, F, FI, NY, P (orig.).
BORNMÜLLER, A.: A, G-DEL, GH, NY.
BRENNING, M.: B (c. 400).
CABRERA, A. L.: F, NY, S, SP, US.
COMBER, H. F.: E.
CUMING, H.: CGE, NY.
CUNNINGHAM: BP.
DAHLGREN, B. E.: NY.
DARWIN, C. R. (1833-39): CGE, K, P.
DEAM, C. C.: MICH.
EKMAN, E. L.: K, S.
EKMAN, E. L., DUSÉN, P. *et al.*: MICH (1941).
FAIRCHILD, D.: NY, US.
FRIES, R. E. (1901-02): B (241), S.
GAUDICHAUD-BEAUPRÉ, C.: B, BR, FI, G-DC (2343), D-DEL, L, NY, P (more than 10,000, orig.), W. The collections were made on the following voyages: Uranie 1817-20, Herminie, 1831-33, Bonite 1836-37.
GOODSPEED, T. H.: UC.
HAENKE, T.: B, F, NY, PR (large orig. collection), W.
HILL, A. W. (1902-03): K (585).
HINDS, R. B. & G. BARCLAY (1836-39): K.
HITCHCOCK, A. S.: US.
HUMBOLDT, A. VON & A. BONPLAND (1790-1804): B (large coll.), L, P (4000, orig.).
JAMESON, W.: B, BM, C, E (900), G, GH, K, LA, LE, P, UPS, US, W.
KARSTEN, H. G. K. W.: B, L, NY.
KILLIP, E. P. & A. C. SMITH: NY (15459).
KING, PH. P.: BM (1120). Collected during voyage of survey on the *Adventure* and *Beagle*.
KREBS, O.: E (2000).
KUNTZE, O. (1891-92): B (1310), E, F, G-BOIS, K, L, MO, NY, US.
LEHMANN, F. C. (1880-99): B (3811), BM (3369), F, G, GH, K (7300), L, LE, NY, US, W.
LOBB, W. (1840-48): K.
MEXIA, Y.: A, B, BM, C, CAS, F, G-DEL, GH, LA, LCU, MICH, MO, NY, P, PH, S, POM, UC, US, USFS, U.
MEYEN, F. J. F. (1830-32): B, K.
NÉE, L. (1789-1794): C, MA (orig.).
D'ORBIGNY, A. C. V. (1826-33): BR, G-DC, P.
PAVÓN, J.: BC, BM.
PARODI, L.: GH, L, NY, W.
PHILIPPI, R. A. (1872): B (4000), BM, F, G, K, LE, NY, O, P, S, SI, UPS, US, W, WU.
POEPPIG, E.: BM, PR (180).
PURPUS, A.: E.
ROSE, J. N.: US.
RUÍZ, H. & J. PAVÓN: B, BM, F, G, K, MA (3000, orig.), NY, P.
RUSBY, H. H.: B, BKL, BM (1435), COLU, E, G-BOIS, GH, K, LE, LA, MICH (1650), MO, NY, PH, PRI, TRIN, US, W.
SAVATIER, P. A. L.: K (735).
SCHLIM, L.: CGE.
SPRUCE, R.: (1849-64): B, BM (6700), BR, C, E (8500), F, G, GH, GOET, K, LD, LE, M, NY, P, S, W.
STÜBEL, A. (1868-77): B (c. 3000).
WARSCEWICZ, J. VON (1845-53): B (c. 500), G-BOIS, KRA.
WEDDELL, H. A. (1843-51): G-DC, L, NY, P (4754, orig.).
WILKES, C. *et al.* (U. S. Expl. Exp. 1838-42): US.

— Venezuela —

APPUN, C. F. (1849-59): BM, K, LZ, NY.
BREDEMEYER, F. (1786-88): B-W, W.
CURRAN, H. M. (1917): GH.
EGGERS, H. F. A. Baron VON (1891): C.
ERNST, A. (1861-99): VEN. His herbarium is nearly completely destroyed by insects.
FENDLER, A. (1851-58): BUF, BM (182, Filic.), E, F, G, GH, GOET, K (c. 3000), MO, NY, P, PH, US.
FUNCK, N. & L. J. SCHLIM (1840-43): B, F, G-DC, G-DEL, GENT, K, L, LD, LE (819), LZ, P, BM,
GOLLMER, J. (1852-57): B (1936, incl. St. Thomas, orig.), KIEL, L.
GROSOURDY, R. DE: P (869 incl. Puerto Rico).
HUMBOLDT, A. VON & A. BONPLAND (1799-1800): B-W, P (orig.).

JACQUIN, N. J. (1756): B-W (270), BM.
JAHN, A. (1887, 1910-12, 1915-17, 1921-22): US (orig.), VEN, W.
LANSBERGE, J. G. VAN: B (291), L (orig.).
LINDEN, J. J. (1841-43): BR, CGE, FI, G, GENT (orig.), LG, LZ, P.
MORITZ, J. W. K. (1835-37, 1840-66): B (c. 3000, incl. W. Indies), BM (2850, orig.), FI, G-DE, G-DEL, GH, K, KIEL, L, LE, LZ, NY, O, P, U, W.
OTTO, C. F. E. (1839-41): B (1567, orig.), BR, C, E, K, KIEL, L, LE, W.
PASSARGE, S. (1901-02): B (800).
PITTIER, H. (1913, 1918- ): B, US (large coll.), VEN (large coll.).
PITTIER, H. *et al.*: B (1588), K (415), VEN.
PLÉE, A. (1824): B, L, P.
PURDIE, W. (1851): K.
SPRUCE, R. (1853-55): K.
TATE, G. H. H. (1928-29): NY.
TEJERA, E. (1917-18): GH, US (orig.).
THOMSON, R. (1868-79): K.
ULE, E. (1909-10): B. Collected on Mount Roraima.
VÁRGAS, J. M.: F, FI, G-DC, NY.
WAGENER, H. (1848-52): B, K.
WILLIAMS, L.: F.

— British Guiana —

ALSTON, A. H. G. (1925-27): K (450).
American Museum of Natur. Hist.: NY (659).
ANDERSON, A. (1791): BM, G-DEL.
APPUN, C. F. (1863-67): BM, K.
ARCHER, W. A. (1935): K (195).
BARTLETT, A. W. (1906-08): B (378), BRG, F, K (130), NY.
BOZ, A. C.: K, NY.
Brit. Guiana Dept. of Agric. (1924-37): K (1050).
Brit. Guiana Forest Dept. (1930-36): K (290), NY, U.
CAMPBELL, W. H. (1871): K (275).
DE LA CRUZ, J. S. (1922): F, GH, K (500), MO, MICH, NY (1234), PH, UC, US.
DAVIS, T. A. W. (1932-36): K (385), NY.
GLEASON, H. A. (1922-23): IND, ILL, ISC, K (380), MICH (150), NY (3101, orig.), US.
HITCHCOCK, A. S. (1920): US.
HOHENKERK, L. S.: K (435).
IM THURN, E. F. (1879-85): BM (315), K (1005), P.
JENMAN, G. S. (1875-1902): B (520), BM (630), BRG, COLU, DR, F, K (4900, orig.), L, MICH, NY, P, PH, U, UC, US.
LOCKIE, J. R.: K, NY.
MCCONNELL, F. N. & J. S. QUELCH (1899): –Roraima– B (16), K (orig.).
MARTYN, E. B. (1929-31): BRG, K (385), NY.
MYERS, J. G. (1936): BM, K (225).
PARKER, C. S. (1824): K.
PINKUS, A. S. (1938-39): A, BR, F, M, NY (230, orig.), S, U, US.
SANDWITH, N. Y. (1929, 1937): B, K (1322, orig.), NY, U.
SCHOMBURGK, Sir ROBERT (1835-43), and Sir RICHARD (1840-44): B (1803), BM (2341), BR, CGE, COLU, DR, E, F, FI, G-DC, G-DEL, K (orig.), L, LZ, NY, P (1000), U, UPS, US. It is not always certain if the specimens are from Sir RICHARD or Sir ROBERT, therefore they are listed here jointly.
SMITH, A. C. (1937-38): A, F, G-DEL, GH, K, MO, NY (1600, orig.), P, S, U, US, YU.
TUTIN, T. G. (1933): BM (orig.), K, U.

— Surinam (Netherlands Guiana) —

ALLAMAND, F. (1756-71): LINN.
BOON, H. (1901): U (220).
BW (Boschwezen = Forestry Bureau) (1915-26): K, L, NY, RB, U (more than 7000, orig.).
DAHLBERG, C. G. (1754-55): LINN.
ESSED, E. (1914): L, U (orig.).
FOCKE, H. C. (1835-50): L, U (orig.).
GONGGRIJP, J. W. (1909-23): U.
HOSTMANN, F. W. (1824-40): B (415), BM (1168), BP, C, CGE, F, FI, G-BOIS, G-DEL, GH, K (1400), L, LZ, MO, KIEL, NY, P, GOET, S, U, W.
HOSTMANN, F. W. & A. KAPPLER: B, C, E, G-BOIS, G-DEL, GH, K, LE (684), M, MO, NY, P, S, U, W.
HULK, J. F. (1910-11): U.
KAPPLER, A.: B, BRSL, C, DR, FI, G-BOIS, G-DEL, K, KIEL, L, LE, LZ, GOET, M, MO, P, S, U, UPS, W, WB.
KEGEL, H. (1844-45): B (Filic.), BR, GOET (orig.), L.
KUYPER, J. (1911): L, U (orig.).
LANJOUW, J. (1933): BM, K, NY, P, RB, U (1350, orig.).
PULLE, A. A. (1903-04, 1920): B, L, NY, RB, U (c. 1000, orig.).
ROHR, J. P. B. VON: C.
ROLANDER, D. (1755): LINN.
ROMBOUTS, H. E. (1935-38): U (900).
SAMUELS, J. A.: A, B, GH, K, L, NY, P, US.
SPLITGERBER, F. L. (1837-38): BM, CGE, G-DEL, GOET, K, L (orig.), NY, P, W.
STAHEL, G. (1914-39): BM, BR, K, NY, RB, U (orig.).
Suriname Dept. of Agric. (1906-10): U.
TRESLING, J. (1908): U.
TULLEKEN, L. (1900): L (500).
VERSTEEG, G. M. (1903-04): U (950).
WEIGELT, C. (1827-28): B, BR, C, FI, G, GOET, KIEL (probably most complete set), L, LZ, PH, W.
WENT, F. A. F. C. (1901): U (550).
WULLSCHLAEGEL, H. R. (1849-55): B, BR (orig.), DR, GOET, M, U, W.

— French Guiana —

AUBLET, J. B. C. F. (1762-64): BM, Herb. Denaiffe at Carignan (part of Type collection). *See* for particulars on this important collection LANJOUW & UITTIEN in *Rec. trav. bot. néerl.* XXXVII, 1940, p. 132-170.
BENOIST, R.: P.
BROADWAY, W. E.: NY.
GABRIEL: BKL, G-DEL.
JELSKI, K. (1865-69): B, NY.
LEBLOND, J. B. (1802): G-DEL, NY, P (orig.).
LEPRIEUR (1830-36): FI, G-DC (443), G-DEL, K, L, P (orig.), S, U, W.
MARTIN, J.: B, BM (1172), BR, FI, G-DEL, K, L, P (orig.), U.
MÉLINON, M. (1840-62): B, BM, BR, F, G-DEL, GH, K, L, NY, P (orig.), PH, U, US.
PERROTTET, G. S. (1840-41): G, P.
POITEAU, A. (1817-22): B, F, FI, G-DEL, K, LE, MO, NY, P (orig.), PH, W.
RICHARD, L. C. M. (1781-85): C, G-DEL, P (orig.).
PATRIS: G-DC (2000, orig.).
ROTHERY, H. C. (1844-45): B (192), BM (247), K, U.
SAGOT, P. A. (1854-78): B (460), BM (954), BR, F, G, K (1002), L, NY, P (orig.), S, U, W.

— Brazil —

ALLEMÃO, Freire F. (1832-61): K, NY, R (orig., but most of the specimens are destroyed).
BESK, J. (1835): PR (200).
BEYRICH, H. K. (1822-23): B, BM (Musci), DR, KIEL, L, LE (600), LZ, MICH, P, S, W.
BLANCHET, J. S. (1828-56): B, BM (350), BP, BR, C, COLU, DR, E, F, FI, G, K (690), KIEL, L, LE, LZ, M, MO, NCY, NY, OXF, P, LD, S, SP, U, W, WB.
BORNMÜLLER, A.: –Rio Grande do Sul– A, B, BRSL (400), G-DEL, GH, NY, U.
BRADE, A. C.: B, NY, R, S, SP.
BUNBURY, Sir C. J. F.: BR, CGE (orig.), K (400), LIN.
BURCHELL, W. J. (1825-30): BR (1200), COLU, FI, GH, K (11765, orig.), L, LE (1300), NY, P, W.
CAMPOS PORTO, P.: B, NY, R (orig.), S, U.
CASARETTO, G. (1839-40): F, G-DC (693), GE (500), TO (orig.).
CHAMISSO, A. VON (1815-16): B, KIEL, L, LE (10-12000, orig.).
CHASE, AGNES (1930): –*Gramineae*– A, F, K (65), MICH (600), MO, NY (211), US.
CLAUSSEN, P. (1834-43): B (700), BM, BP, BR, C, CGE, COLU, F, G-DC (708), G-DEL (orig.), GH, K, L, LE, LZ, MO, KIEL, AWH, FI, NY, P, R, S, TLM, U, UPS, W.
CUNNINGHAM, A. & J. BOWIE (1814-17): BM, K.
DIDRICHSEN, D. F. (1840): C.
DORRIEN-SMITH, Miss G. (1927): –Matto Grosso– K (335).
DROUET, F.: F, GH, L, LCU, MO, NY, S, US.

DUCKE, A.: A, B, BM, F, G, K (1960), NY (686), P, R, RB (orig.), S, U (large coll.), US, Y.
DUSÉN, P. (1902-15): B, BRSL, F, G, GH, K (1870, incl. Patagonia), L, LA, LCU, LD (500), M, MA, MICH, MO, NY, PH, R (orig.), S, SI, U, UPS, US.
DUTRA, J. (1902-05): –Rio Grande– MVH, SI.
EDWALL, G. (1891-1905): B, C, NY, SP.
EMMICH: –Rio Grande– MVH.
ENDLICH, R. (1896-98): –Matto Grosso– B, L.
FERREIRA, A. R. (1783-92): K, LISC (orig.).
FREYREISS, G. W. (1813-25): S, etc.
FRÓES, R.: A, B, BM, F, G-DEL, K, LA, LCU, MICH, MO, NY (orig.), P, S, U, US. Collected with KRUKOFF.
GARDNER, G. (1836-41): B (1731), BM (5746), BR, CGE, DR, E, F, FI, G, GH, K (6110, orig.), L, M, NY, P (1357), S, US, W.
GINZBERGER, A.: F, WU (1000, orig.).
GLAZIOU, A. F. M. (1861-95): A, B, BM, BR, BRG, BRSL, C, COLU, F, FI, G, GH, K (22799), L, LE, MA, MPU, NY, P, R, S, STR, U, US.
GOELDI, A.: F, G-DEL, NY (349, *Gram. & Cyp.*). PG (orig.), U.
GOELDI, E. A.: L, NY.
GUILLEMIN, A. (1838-39): DI (orig.), F, FI, G-DC, G-DEL, K, NY, P.
HOEHNE, F. C.: A, B, BRSL, GH, K, NY (576), SP, US.
HOWE, M. A.: NY (Algae).
HUBER, J. (1895-1910): B, BM, F, G, NY, PG (orig.), U, US.
JÜRGENS, C.: B.
KARWINSKI, W. F. VON (1821-23): M.
KERR, J. G.: K (272).
KILLIP, E. P. & A. C. SMITH (1929): NY, US (500, orig.).
KLEEREKOPER, H.: PH (Algae).
KRUKOFF, B. A.: A (3656), B (2066), BM (2828), BR (1051), BRI (128), BKL (55), F (2548), G (3415), K (3478), LCU (279), LE (109), LP (1053), M (949), MICH (2997), MO (2901), NY (5499), P (915), R (1493), S (3168), U (3307), US (2616).
KUHLMANN, J. G.: B, NY, RB (orig.), S, SP, U, UPS, US.
LANGSDORFF, G. H. VON (1813-29): B, LE, (3000, orig.), NY.
LAY, G. T. & A. COLLIE (1825-28): K.
LESCHENAULT, L. T. (1923-24): G-DC, G-DEL, NY, P (orig.), U.
LHOTSKY, J. (1830-32): B, G-DC, K, BR, LE, LZ, NY, PR (300).
LINDBERG, G. A. (1854-55): BR (759), S (orig.), UPS.
LINDEN, J. J. (1835-37): BM, BR, FI, GENT (orig.), K, LE, G, OXF, P, W.
LINDMAN, C. A. M. (1892-94): –Rio Grande do Sul– B, BRSL, G, GH, K, LD, NY, R. S (orig.), UPS, W.
LOBB, W. (1840-48): K.
LÖFGREN, A. (1874-87): C, B, GH, NY, S, SP (orig.), U.
LÖFGREN, A. & G. EDWALL: B (c. 850), C, NY, SP (orig.).
LUETZELBURG, PH. VON: B, BRSL, F, M, NY (675), W.
LUND, P. W. (1825-35): C.
LUSCHNATH, B. (1831-37): B (365), BR (1450), C, KIEL (orig.), L, LE, NY, U.
MALME, G. O. A. (1892-94, 1901-03): B (c. 400), BRSL, G-DEL, GH, LD, NY, R, S (orig.), UPS, US.
MARTIUS, K. F. P. VON (1817-20): AWH, B, BM, BR, CGE, E, F, FI, G-DC, G-DEL, GH, K, KIEL, L, LE (1500), LZ, M (orig.), MO, NY, P, S, U, W, WB, WU.
MENDONÇA, R. (1881-88): B (1426).
MEXIA, Mrs. Y. (1929-32): B, K (2075, incl. Peru), U, WELC (573).
MEYEN: KIEL.
MIERS, J. (1831-38): BM (orig.), CGE, K.
MIKAN, J. C. (1817-18): W.
MOORE, SPENCER LE MARCHANT (1891-92): –Matto Grosso– B (518), BM (1100, orig.), COLU, E, K, NY, P, R, W.
MOSÉN, C. W. H. (1873-76): B, BRSL, C, LD, O, P, S (orig.), U, UPS, US.
MOURA, J. T. DE (1884-90): B (871).
MUELLER, F. (1852-97): K (505), R.
MULFORD Company, A. H.: BKL, NY (2300, incl. Bolivia).
OLFERS, I. F. W. M. VON (1816-18): B.
PABST, C. (1846-51): B (410).
PECKOLT, T. (1848-68): BR, W.
PICKEL, D. B.: B (292), BH, F, GH, LCU, MICH, NY, S, U, US.
PILGER, R. (1898-99): B (700).
POEPPIG, E. (1831-32): B, BM, BR, G, GOET, L, LE, LZ, W (orig.).
POHL, J. E. (1817-21): B, BM, BR, F, G-DC, K, KIEL, L, LE (600), M, MO, NY, P, PR (1000), PH, U, W (orig.).
PUIGGARI, J. J.: P, WU (1400).
RADDI, G. (1817-18): BP, BR (Filic.), FI, (orig.), PI.
REGNELL, A. F. (1841-74): B (2850), BP, BR, BRSL, C, G-DEL, GH, HAL, K (1486), LCU, LD, LE, M, NY, O, P, R, S (orig.), U, UPS, US, W, WU.
REINECK, E. M. & J. CZERMAK (1896-99): B (41), BRSL (300), P, POM.
RICHARD, L. C. (1785): P.
RIDLEY, H. N. (1887): BM.
RIEDEL, L. (1821-36): B, F, FI, G-BOIS, BR, K, L, LE (orig.), NY (811), R, SI, U, UPS, US, W.
ROBERT, A. (1902-03): B (226), BM, K (400).
RONDON: NY, SP (orig.).
SAINT-HILAIRE, A. F. C. P. DE (1816-22): B, F, G-DEL, K, MPU, NY, P (7608, orig.), US.
SALZMANN, P. (1827-30): AWH, B, BR, CGE, E, FI, G-DC (781), G-DEL, K, LE, MO, MPU (orig.), NCY, P, W.
SAMPAIO, A. J. DE: B, NY, R (orig.).
SCHENCK, J. H. R. (1886-87): B (2000), C.
SCHOMBURGK, ROB. (1835-39): K, BM.
SCHOTT, H. W. (1817-21): B, BR, L, U, W (orig.).
SCHWACKE, C. A. W. (1873-1904): B (2350), G-DEL, GOET, NY, R.
SELLO(W), F. (1814-31): B (11750, orig.), BM, BR, CGE, G-BOIS, G-DEL, GH, K, KIEL, L, LD, LE (1300), LISU, LZ, NY, P, R, S, U, UPS, US, W, WU.
SIEBER, F. W. (1801-07): B.
SILVEIRA, A. A. DA (1894-1907): B (487).
SPRUCE, R. (1849-55): AWH, B, BM, BP (1800), BR, C, CGE, E, F, FI, G-BOIS, G-DC, GH, K (orig., 9931, incl. Peru and Ecuador), L, LD, LE, M, MICH (Musci), NY, P, S, TCD, W.
SWAINSON, W. (1816-18): GH, K, LIV (1200, orig.).
SWALLEN, J. R. (1934): K (140, *Gram.*), L, MICH (390), US.
TRAIL, J. W. H. (1873-75): K (1646, orig.), NY.
TWEEDIE, J. (1832): K, LE, U, W.
ULE, E. (1883-1912): B (c. 8000, orig.), BM (650), BP, BRSL, (600), F, G, GOET, HBG, K (4100), L, LE, NY (391, Musci), P, PR, R, U, US, W.
USTERI, A.: –São Paulo– B, K (500), M, NY, SP.
VAUTHIER: G-DC, G-DEL, NCY, L, P (560, orig.).
WAINIO, E. (1892): K (500).
WALLIS, G. (1854-68): B (427), NY.
WARMING, J. E. B. (1863-66): BM, BR, C (orig.), F, K (104), L, MO, NY, O, P, S, US, W.
WAWRA, H. (1857-60, 1879): B, BP, NY, W (orig.).
WEDDELL, H. A. (1843-45): P.
WEIR, J. (1861-63): BM, FI, K.
WETTSTEIN, R. VON (1901): B (254), WU (4000, orig.).
WHITE, O. E.: *See* MULFORD.
WIDGREN, J. F. (1841-47): B, BM, BR (1100), C, GH, K, LD, M, NY, O, R, S (orig.), U, UPS, US, W, WU.
WIED-NEUWIED, M. A. P. Prinz zu (1815-17): B (100), BR (650, orig.), G-DEL, GENT, LD, LE.
WRIGHT, S.: PH (Algae).

— Colombia —

ANDRÉ, E. (1875-76): F, K (14250, orig.), NY, W.
APOLLINAIRE: L, US.
ARBELÁEZ, E. P.: MA (orig.), US.
ARCHER: MA.
BARTHOLOMEW, E.: MICH (Fungi Colomb. Exs. cent. 1-51).

BERTERO, C. G. (1820-21): HAL.
BUKASOV, S. M.: WIR.
CUATRECASAS, J.: B, BOG, COL, MA (orig.), NY, US.
DRYANDER, Mrs. E.: B, C, NY, US.
DUGAND, A.: COL.
ELÍAS, Hno.: MA.
ESCALLON (1777): LINN.
FUNCK, N, & L. J. SCHLIM (1845): BR, G-DEL, GENT, LZ.
GOUDOT, J.: FI, G, K, P (orig., 3000), W.
HARTWEG, TH.: B, BM, G, L, LD (orig.), LE, K, W.
HOLTEN, H. VON (1855): K, G-DC (586).
HOLTON, I. F. (1852-53): K, NY.
HUMBOLDT, A. VON & A. BONPLAND (1801): B, P.
KALBREYER, W.: B, K.
KARSTEN, H. (1846): B, BM, G-DC (200), GOET (300), K, KIEL, L, LE (2000, orig.), NY, P, W.
KILLIP, E. P. & A. C. SMITH (1926-27): A, B, F, GH, K, LE, MA, MO, NY, US (7000, orig.).
KLUG, G.: B, MICH, NY, US.
LANGLASSÉ, E. (1899): B (100), G-DEL, GH, K, NY, P, US.
LAWRANCE, A. E.: A, B, F, G, K (495), MICH, MO, NY (573), S, U, US, UC.
LEHMANN, F. C.: B, L, NY (1854).
LINDEN, J. J. (1841-43): BM (1143), BR, K, G-DC (2066), LZ, P, W.
LINDIG, A. (1869): BM (667, Lich. & Bryoph.), K (300).
LOBB, W.: K.
MAYOR, E.: Herbarium of G. S. West (Algae).
MUTIS, J. C. (1760-1808): B, F, G-DEL, K, LIN, MA (6000, orig.), NY, P, S, US.
PENNELL, F. W., E. P. KILLIP & T. E. HAZEN (1922): GH, K, NY, PH, US.
PENNELL, F. W. & H. H. RUSBY (1917): GH, K (350), NY (2151).
PURDIE, W. (1844-45): K.
ROHR, J. P. B. VON: C.
SCHLIM, L.: FI, BM (465), K (878), L.
SCHULTZE, A.: B.
SMITH, H. H. (1898-1901): A, B (2075), BM, BR, E, F, G-DEL, GH, K (2546), L, LE, MO, NY (691), O, P, PH, S, U, US, R, W.
SNIDERN, KJ. VON: B, S (orig.).
SPRAGUE, T. A. (1899): K (500).
TRIANA, J. J. (1854-92): B, BM (4490), BR, E, FI, G-DC (1582), K (2408), L, NY, P (orig.), US, W, COL.
TURNER, W. (1830-45): K.

— Ecuador —

ANDRÉ, E.: F, K, NY (997), W.
COUTHOUY: BUF, F, GH, NY, PH.
DIELS, L. (1933): B.
EGGERS, H. F. A. (1891-97): B (880), C (orig.), K (587), MA.
HAGEN, V. W. VON: NY (549, incl. Honduras & Galapag.), W.
HALL, F. (1831-32): K.
HARTWEG, TH.: B, BM, CGE, G, K, LD (orig.), LE, W.
HAUGHT, O.: US.
HEINRICHS, Miss E.: B (orig.), G-DEL, M, MA, NY.
HITCHCOCK, A. S. (1923): US.
HUMBOLDT, A. VON & A. BONPLAND (1802): B, P.
JAMESON, W.: B (97), BM, C, E, G, GH, FI, K, LA, LE, MA, P, UPS, US, W.
JUSSIEU, J. DE (1735-47): P.
LOBB, W.: K.
PEARCE, R. W. (1868-84): BM, K (incl. Chile and Peru 3166), NY.
PENLAND, C. W. (1939): Colorado College.
SCHIMPFF, H. J. F.: B (366).
SCHULTZE-RHONHOF, Mrs. & A.: B.
SODIRO, LUIS (1876-1908): B (2583), BP (6000), K (865, Filic.), NY (266, chiefly Filic.), SI.
SPRUCE, R. (1855-64): CGE, K.
STEEVE: LZ.

— Galapagos Islands —

ANDERSSON, N. J. (1852): B, BR, C, G-DC (500), GH, K, L, LD, LE, LG, MO, NY, P, S (orig.), UPS, W.
HOWELL, J. T.: CAS, F, LA, NY, POM.
MACRAE, J. (ca. 1825): K.
SCHIMPFF, H. J. F.: A, B, BM, CAS, G-DEL, MO, NY, P, U.
STEWART, A.: CAS, F, GH, K (195), MO, NY, US.
SVENSON, H. K.: B, BKL, F, GH, K, NY, S, UC.

— Peru —

BESSER, VON: B, KIEL.
BONPLAND, A.: CGE, L, P (orig.).
COKER, R. E.: NY (503, marine algae).
CRUCKSHANKS, A. (1829): K.
CUNNINGHAM, A.: G-DC, K (orig.), LIN, M, W.
DOMBEY, J. (1778-84): B, BM, CGE, FI, G-DC (377), G-DEL, L, NY, P (orig.). Collected with RUÍZ and PAVÓN. His plants were studied by L'HÉRITIER, but the latter was murdered and this work has never been published.
GAY, C. (1839-40): P.
HALL, F.: K.
HARTWEG, TH.: B, CGE, FI, G, K, L, LD (orig.), LE, W.
HERRERA, F. L. (1922): B, F, L, NY, SI, US.
HITCHCOCK, A. S. (1923): US.
JELSKI, K. (1870-79): B (90), KRA, NY.
JUSSIEU, J. DE (1755-71): P.
KILLIP, E. P. & A. C. SMITH (1929): A, B, F, GH, K, LE, MA, MO, NY, US (8500, orig.).
KLUG, G. (1931): A, B, CAS, E, F, G-DEL, GH, K (2315), LCU, MICH, MO, NY, S, U, US.
LECHLER, W.: B, BRSL, CGE, L, WB.
LESSON, R. P. (1823): P (Algae).
LOBB, W. (1842-43): K.
MACBRIDE, J. F.: F, GH, MA, NY, US.
MACLEAN, J. (1837-43): K.
MATHEWS, A. (1833-41): AWH, B, BM, BR, CGE, E, F, G-DEL, K (2111), FI, L, NY, P, W.
MEXIA, Mrs. Y. (1929-32): K, U. *See also* under South America.
MEYEN, F. J. F (1831): B.
NATION, W. (1862-80): K (352).
PEARCE, R. W. (1868-84): BM, K, NY.
PENNELL, F. W. (1925): F, GH, NY, PH (orig.).
PHILIPPI, E. B.: B (162).
PHILIPPI: L, WB.
POEPPIG, E. (1829-31): B, BM, BR, F, G, K, KIEL, L, LE, LZ, GOET, MO, NY, P, U, W (orig.).
RAIMONDI, A.: B, Lima.
RUÍZ, L.: MA.
RUÍZ, H. & J. PAVÓN (1778-88): B, BM (1500), CGE, F, G-DEL, K, FI (4000), MA (3000), NY, P.
RUTTEN, L. (1921): U.
SPRUCE, R.: CGE, K, L, *See also* under Brazil.
STAFFORD, Miss D. B. (1933-37): K (c. 750).
STEEVE: LZ.
TESSMANN, G.: B (orig.), F, G-DEL, NY, S.
ULE, E.: B (orig.), L. *See also* under Brazil.
WEBERBAUER, A. (1901-05): B (c. 5200, orig.), F, G, GH, K (350), NY, S, US.
WEDDELL, H. A. (1847, 1851): P.
WILLIAMS, L.: B, F, GH, LA, NY, S, US.
WILLIAMS, R. S.: BM, K, NY, US.

— Bolivia —

ANDRÉ, E.: F, K, NY, W.
BANG, M. (1890-95): A, B (2372), BM, BRSL, C, COLU, E, F, G, GH, ISC, K (962), L, LD, LE, MICH (860), MO, NY, O, PH, S, TRIN, UC, US, W, WU.
BARCLAY, G. W.: BM, K, NY.
BRIDGES, T.: B, BM (533), CGE, G, K, LE, NY, W.
BUCHTIEN, O.: B, BP (620), BRSL, C, E, F, G, K (1025), L, LA, LD (150), M, NY, O, S, SI, SP, U, US, W, WU.
FIEBRIG, K. (1903-04): A, B (1544), BM, BRG, E, F, G, GH, K, L, LD (120), M, NY, SP, U, US, W.
HAENKE, T. (1796-1817): PR.
HERZOG, TH.: B, G, K (300 Bryoph. incl. Chile), L, M, NY, S, W.
HITCHCOCK, A. S. (1923): US.
MANDON, G. (1863-83): B, BM, F, G, GH, K, L, LE, NY, P, S, W.
MULFORD Company, A. H.: B, NY.
PFLANZ, K. (1907-11): B, NY, US.
QUACK: MVH.

RUSBY, H. H. (1885-87): B (513), BRSL (2500), K (incl. Peru 1565). *See also* under South America.
STEINBACH, J. (1915-29): B, BA (1806), BM, E, F, G, GH, K (2550), MO, NY, PH, S, SI, U.
ULE, E.: B, L. *See also* under Brazil.
WEDDELL, H. A. (1845-47, 1851): P.
WILLIAMS, R. S. (1901-03): BM, K (1600), NY, US.

— **Chile** —

ANDREAS, Miss CH. H. (1937-38): U (c. 900).
BERNINGER, O.: B (981).
BERTERO, C. G. (1828-29): B, BM, FI, G-DC, G-DEL, KIEL, L, NCY, P (1078), SGO (536), TO (orig.).
BESSER, VON: B, KIEL.
BORCHERS, A.: BM (1350), SGO (220).
BRIDGES, T. (1829-44): B (266), FI, G-DEL, K, LE, LZ.
BUCHTIEN, O. (1895-97, 1903-04): B (150), L.
COMBER, H. F. (1925-27): E, K.
CRUCKSHANKS, A. (1826-27): K, NY.
CUMING, H. (1826-31): BM, BP, BR, C, E, F, G-BOIS, G-DEL, K, KIEL, FI, L, LE, LZ, NY, W.
CUNNINGHAM, A.: K, NY.
DOMBEY, J.: *See under* Peru.
ELLIOTT, C. & W. B. GOURLAY (1927-30): K (500), NY.
GAY, C. (1828-42): B, BM, BR, F, G, GH, K, NY, P (orig.), SGO (1235), W.
GERMAIN, P. (1856-57): BM (702), G-DC (500), K (508), P, SGO (687).
GEISSE, G.: SGO (360).
GILLIES, J. (1827): BM, CGE, E, FI, K, NY.
HAENKE, T.: F, MA, NY.
HOLLERMAYER, A.: B (230), G, K, LD, M, NY, S, US.
HOSSEUS, C. C.: B, BP.
JOHNSTON, I. M. (1925-26): BA (431), GH, K (653, incl. Argent.), MICH, MO, NY, POM, S, US.
LANDBECK, L.: SGO (537).
LAY, G. T. & A. COLLIE (1825, 1828): K.
LECHLER, W.: B, BM, BRSL, CGE, F, FI, G, K, L, LZ, MB (orig.?), NY, O, P, S, SGO (213), UPS, W, WB. The herbarium of LECHLER has been owned by WIGAND at Marburg. It is possible that it is now at the University of Marburg.
LESSON: L.
LOOSER, G. (1927-31): MVH, NY, SI.
MACRAE, J. (1824-26): K.
MEYEN, F. J. F.: KIEL.
MIERS, J. (1819-25): BM (orig.), F, G-DEL, K, NY, P.
MOLINA, J. I.: BO.
NEGER, F. W. (1894-97): B (288), L, M.
PAVÓN, J.: MA.
PEARCE, R. W.: BM, K, NY.
PENNELL, F. W. (1925): F, GH, NY, PH (orig.).
PHILIPPI, E. B.: B (c. 200).
PHILIPPI, F.: BA (348), BM, BP, G-BOIS, G-DC (1500), K, L, LE, LZ, MA, P, W, SGO (540).
PHILIPPI, R. A.: B (c. 1700), BM (564), F, G, K, LE, NY, O, P, S, SGO (563), UPS, US, W, WU.
POEPPIG, E. F. (1827-29): B, G-DC, G-DEL, GOET, K, KIEL, L, LE, LZ, W.
REED, E. C.: BM (773), GH, K.
REICHE, C. (1895-1903): B (760), M, NY, SGO (682).
RUIZ, H. & J. PAVÓN (1782-83): B (1620), MA.
VOLKMANN: SGO (500).
WERDERMANN, E. (1923-26): A, B, BM, E, F, G, GH, K (1125), MO, NY, S, SI (400), U, US.

— **Juan Fernandez** —

BERTERO, C.: B, G-DEL, SGO, TO (orig.).
GAY, C.: G, NY, P (orig.), SGO.
SKOTTSBERG, C. (1921): B, GB (orig.), LD (200), NY, SGO, UPS.

— **Paraguay** —

BALANSA, B. (1874-84): B (640), BM, BP, BR, BRSL, C, E, G, K (3072), L, LA, LE, NY, P, LD (300), S.
BARCLAY, G. W.: BM, K, NY.
DURIEU DE MAISONNEUVE, E.: BM (439).
DÚSEN, P.: NY (195), S (orig.). *See also* under Brazil.
ENDLICH, R. (1896-98): B.
FIEBRIG, K. (1906-10): B (1850), K (2830, incl. Bolivia), L, NY, SI. *See also* under Bolivia.
HASSLER, E. (1898-1916): A, B (c. 4300), BM, BRSL, C, E, F, G, GH, K (7075), L, MO, NY, P, SI, US, W.
HASSLER, F. A. (1897): K (1351).
JÖRGENSEN, P. (1929): C, F, G, GH, LA, MO, NY (1263), P, PH, S, SI, SP, UC, US.
LINDMAN, C. A. M. (1893-94): B, BRSL, S (orig.).
LORENTZ, P. G. (1881): B.
MORONG, T.: BM (608), NY, WELC.
ROJAS, T. (1921): B (c. 2000), L, M, MO, MVH, NY, SI, US. Collected for E. HASSLER.

— **Uruguay** —

ARECHAVALETA, J.: B (773), BRSL, F, G, K, L, MVM (orig.), NY.
BERRO, M. B.: K (665), G.
CHAMISSO, L. A. de: B.
CHEBATAROFF: K, MVH.
COMMERSON, P. (1767-69): P (orig.).
FELIPPONE, F. (1917-32): B (Lich.), K (525), LE, NY (Musci & Algae), SI (large coll.).
GAUDICHAUD-BEAUPRÉ, C.: *See under* South America.
GIBERT, J. E.: K.
HERTER, W. G.: B, C, F, GH, K, L, LA, MICH (150 Fungi), MO, MVB, MVH (5000, incl. Braz., Parag. & Argent., orig.), SI, U, UC, W.
HIERONYMUS: BP.
HOSSEUS, C. C.: BP.
LANGERON: MVH.
LORENTZ, P. G. (1875): B, K, L, TO.
OSTEN, C. (1891-19..): B, G, L, NY, Herb. Osten (orig.), SI.
SAINT-HILAIRE, A. DE (1820-21): *See under* Brazil.
SELLO(w), F. (1821-23, 1826): *See under* Brazil.
TWEEDIE, J. (1832): *See under* Brazil.

— **Argentine** —

AMEGHINO, C. (1890-1903): -Patagonia- BA (188), NY.
BERG, C. (1874): -Patagonia- BA.
BUNBURY, Sir C. J. F.: CGE (orig.), K.
BURKART, A. (1926-37): B, BA (462), K (160), NY, SI (700, orig.).
CABRERA, A. L. (1928-33): F, NY, S, SI (orig.), SP, US.
CARETTE, E. (1921): NY, SI (400, orig.), SP.
CASTELLANOS, A. (1917-37): BA (8100), NY, SI.
CASTELLANOS, J. C. (1926-32): -Córdoba- BA (1073).
COMBER, H. F. (1925-27): K (1200, incl. Chile).
COMMERSON, P. (1767-69): FI, G-DEL, L, MPU, NY, P (orig.).
COPPINGER, R. W.: -Patagonia- K (159).
CRUCKSHANKS, A. (1826-27): K.
DAGUERRE, J. B. (1925-32): BA (510), NY.
DESCOLE, H. R.: LIL.
DONAT, A. (1929-37): -Patagonia- B, CAS, K (500), NY, SI, U.
DUSÉN, P. (1896-1905): -Patagonia- B (200), BM, K, L, SI (Bryoph.).
FISCHER, W.: ILL, K (285), NY (568).
FRENGUELLI, J.: LP (Algae).
GALLARDO, C. (1900-01): BA (264).
GIBERT, E.: K.
GILLIES, J. (ca. 1835): K, BRNU.
HAUMAN, L. (1904-25): BA (2100), NY.
HICKEN, C. M. & L. HAUMAN (1924): SI.
HIERONYMUS, G.: B, BA, BP, BR, BM (177), K (179), P, SP.
HOSSEUS, C. C.: B, BP.
JAMESON, W.: K.
JOHNSTON, I. M. (1925-26): GH, K, MICH, MO, NY, POM, S, US.
JÖRGENSEN, P. (1909-23): BA (900), C, F, G, GH, LA, MO, NY, P, PH, S, SI (more than 1000), SP, US, UC.
KÜHNEMANN, O. (1935-39): BA (750).
KURTZ, F.: B (161), Herb. Kurtz, Córdoba (17000, orig.), NY (300), SI.
LILLO, M.: -Tucumán- NY, SI, LIL (orig.).
LORENTZ, P. G. & G. HIERONYMUS (1870-81): B, BA, BM, BR, BRSL, CORD (orig.), E, G, K, L, M, NY, SI, W.

MIERS, J. (1819-25): BM.
NIEDERLEIN, G.: B (c. 1600), NY, PH.
O'DONNELL, C. A.: LIL.
PARODI, L. R.: LP.
PASTORE, F. (1906): SI (1000).
PÉREZ MOREAU, R. A. (1923-37): BA (1600), NY.
QUIROGA, H. (1910-13): BA (348), G, NY.
RODRIGUEZ: (1909-35): BA (1500), NY, SI.
RODRIGUEZ, F. M.: SI.
RUIZ LEAL, A. (1915-25): BA (591).
SAIL ECHEGARAY, D.: CORD.
SCHNYDER: LZ.
SCHREITER, R. (1917-35): BA (950), NY.
SCHULZ, A.: -Chaco- MVH, NY, SI, Herb. Schulz, Córdoba, U (*Euphorbiaceae* & *Lauraceae*).
SKOTTSBERG, C.: BA (170), GB (orig.), SI.
SPEGAZZINI, C.: BR, L, LPS (orig.), NY.
TWEEDIE, J. (1832-37): BM, K, LE, W (orig.).
VENTURI, S. (1897-1927): A, B (400), BA (2200), F, GH, NY, SI, SP, US, W.

— Tierra Del Fuego —

BANKS, J. & D. SOLANDER (ca. 1769): BM.
BARCELÓ, J.: BA (43).
CASTELLANOS, A.: BA (402).
COMMERSON, P. (1767-69): FI, G-DEL, L, MPU, P (orig.).
CUNNINGHAM, R. O. (1869): -Magellan- B, FI, K (611).
DARWIN, C. R. (1834): K.
FORSTER, J. R. & G. (1772-75): BM.
FRENGUELLI, J.: LP (Algae).
HALLE & SKOTTSBERG: BA (53), GB (orig.).
HOOKER, J. D. (1842): FI, K (orig.), L.
LABILLARDIÈRE: FI.
LECHLER, W.: -Magellan- B, K, L.
NAUMANN: KIEL.
PENNINGTON, M. S. (1903): BAF (orig.), Z.
ROIVAINEN (1928-29): BA (123).
SULIVAN, Lieut.: CGE.

— Falkland Islands —

COMMERSON, P. (1767-69): P.
EDMONSTON, T. (1837-45): K.
FIRMIN, Miss L. H. (1895-96): K.
HOOKER, J. D. (1842): K.
LECHLER, W.: B, K, L.
LESSON: L.
LINNEY, M. A.: K.
SKOTTSBERG, C. (1907-09): B (112), GB (orig.), NY.
SULIVAN, I. B. (1842-52): K.
VALLENTIN, Mrs. E. (1909-11): K (930).

MARSTON BATES: **The Advantage of the Tropical Environment for Studies on the Species Problem:** — Dr. VERDOORN has asked me to discuss my belief in the desirability of "establishing a more or less long range study of the 'species problem' in some group somewhere in the tropics." Such a study implies the need for a laboratory where work on experimental evolution can be carried out in a tropical environment, and the arguments for establishing such a study are identical with those for a laboratory. Existing laboratories in the American tropics, as far as I know them, are largely engaged either on medical or agricultural work of direct practical importance, or else are places of transient study where workers can become familiar with the tropical environment or carry on short term investigations of particular problems. The laboratory at Barro Colorado Island is a fine example of this second class: it fills a very real need and from it have come an extraordinary number of studies of basic biological significance. Yet many of the problems that most need attention are hardly susceptible of attack on a short term basis or by means of periodical or occasional visits. This is particularly true of problems of experimental evolution.

Most work in the tropics has been, in consequence, observational or descriptive. Much of classical evolutionary theory is based on these observations and descriptions, and many of the conclusions would be susceptible of experimental attack. Our ideas of natural selection, for instance, are in large part based on a concept of the tropical rain forest that may have little basis in fact. It is easy to visualize the "struggle for existence" and the "survival of the fittest" in the rain forest — the strangling fig slowly suffocating a palm tree is almost an idealization of this concept — yet we know almost nothing about population pressures, competition and other factors that may actually control survival and dispersal in the rain forest environment. It seems perfectly possible, in view of the frequency of archaic types of organisms and the wide variety of surviving species, that natural selection may actually be a less potent force in the tropical than in the temperate environment. It may be that because of the abundance of food, light and water almost anything can survive and almost everything does.

The abundance of organisms, both as individuals and as species, and the complexity of the environment, may well make tropical studies discouragingly difficult, and there is a great deal to be said for ELTON's contention that ecological studies can best be made in an arctic environment where life is reduced to its simplest terms. On the other hand, it seems to me that the tropics offer some overwhelming advantages, at least in the case of studies of evolutionary phenomena. First, perhaps, is the speed and continuity of growth. Anyone who has struggled to maintain summer environmental conditions in a northern laboratory throughout the winter will appreciate this advantage. In many parts of the tropics studies that would otherwise have to be made in constant temperature rooms can be carried out as field projects. We find that the forest of the upper Orinoco drainage — and the same would probably be true of many other tropical forests — presents an extraordinarily constant physical environment. The whole construction of the forest makes for insulation, and such daily and seasonal shifts as exist in an open pasture, for instance, are greatly dampened in the lower strata of the forest. Conditions that closely approximate those of the lower forest levels can readily be obtained within the laboratory by simply digging a cellar — no thermostats required.

The protean nature of tropical life may also be turned to advantage. A given population is often polymorphic and many similar populations often grow in the same environment, providing endless raw material for study and analysis. The most carefully studied cases of geographical variation (in the animal kingdom, at least) occur in the temperature zone, and involve correlations between structural variation and climatic belts so that phenotypic and genotypic variations are almost inextricably mixed. In the tropics there are abundant examples of geographical variation in apparently uniform climatic environments, and laboratory studies of this material — cross breeding to determine extent of genetic divergence, tests with changes in environmental factors, and so forth — would surely be valuable. For the study of variation

correlated with climatic shifts, it would be difficult to find a more ideal arrangement than that offered by a tropical mountain range. Seasonal discontinuity in growth and seasonal shifts in physical environment are, to a surprisingly large extent, eliminated.

In short, it seems to me that a tropical station, akin to some of the marine stations, with a permanent staff and with a long term program of research on specific taxonomic groups, offers great promise of helping to elucidate some of the basic problems of evolution: the conditions under which the first divergence of populations occurs, the nature of the primary divergence (structural, behavioral), and the relation of such divergence to controlling agencies such as selection.

THE ROCKEFELLER FOUNDATION,
NEW YORK CITY.

KNOWLES A. RYERSON*: **Agricultural Scholarships and Inter-American Relations:** — Among the most helpful methods of increasing general sympathetic understanding between the Americas and, at the same time one of mutual practical aid in furthering agricultural development, is through the use of scholarships. By this means, large numbers of young people not only receive training in their special fields of endeavor preparing them for responsible leadership in their own country, but also, through living and working as fellow students derive an international understanding that will carry on through the years ahead.

If any confirmation of this policy is desirable, one need only to point to the use of the Boxer indemnity funds by the United States in providing scholarships for Chinese students. No single factor has contributed more to goodwill and to sympathetic relations between this country and China. Through this arrangement China has gained trained leaders in all fields of endeavor, who were ready when China's hour of crisis came.

If the war has taught anything to the nations of the Western Hemisphere it is the fact of our interdependence, that the progress and stability of each is vital to the progress and stability of us all.

This is especially true in the field of agriculture, and because of it, the securing of scholarships and fellowships has received first consideration by all those individuals and agencies engaged in furthering inter-American relations in agriculture.

One of the many unfortunate casualties of the war has been the necessary interruption of normal educational activities in our various institutions of learning, and the necessity of devoting their main efforts to specific war training. This seriously curtailed or eliminated scholarships and fellowships right at a time when an enthusiasm and interest by many agencies was resulting in a rapidly increasing number being made available.

No detailed picture of pre-war conditions could be applicable or accurate now, nor would it necessarily be a true forecast of post-war conditions. However, a short résumé of some of the principal activities in this field may serve to outline what was being attempted when war came, and offer some indication as to the possible post-war pattern when peace time plans are again possible.

* Chairman, Advisory Committee on Inter-American Cooperation in Agricultural Education.

The *Institute of International Education*, by long experience and accomplishment, has held a foremost place of leadership over a long period of years. This organization has administered many different types of scholarships and fellowships and student and faculty exchanges throughout the world. Many of these have been in the field of agriculture. The type of scholarship varies greatly, according to the donor, some provide room and board, some tuition, some both, together with travel allowances. The State Department has cooperated in providing travel allowances to make possible the acceptance of some scholarships. It is without the scope of this chapter to try to give a comprehensive list of all those that have been available through this Institute, because of their constant change and augmentation. Such questions can be answered by getting in touch with the Institute at its headquarters, 2-W., 45th Street, *New York, N. Y.*

One group of scholarships administered by the Institute is worthy of special mention. These are the so-called *Roosevelt Fellowships*—extended through the Office of the Coordinator of Inter-American affairs. There are 20 in number providing one for each Latin American republic. These are open to agricultural students and some have been granted in this field. The war interrupted the sending of twenty American students to as many Latin-American countries under the same plan, but it is hoped this will be possible again after the war.

The so-called Buenos Aires Convention, signed December 23, 1936, provided for the exchange by the United States and the other American Republics of one professor and two graduate students with each of the other signatory powers. Most of the countries had signed prior to the war and exchanges had started. Agriculture was included among the first exchanges. The war has delayed the plan but it will be resumed on full scale with the coming of peace.

Under the terms of the convention the inviting country provides tuition and living expenses for the exchange, his home country providing the transportation to and from the institution where his work will be done.

*The Guggenheim Foundation of New York* has been pre-eminent in its generous scholarships and fellowships at the graduate level for students from other countries, including Latin-America and for students of the United States desiring to study in Latin-America. Some of them have been granted in the field of agriculture.

Several State Colleges and Universities especially interested in Latin-American affairs have made special provisions for Latin-American studies in their own institutions, as well as providing scholarships, tuition fees, living expenses in whole or in part.

Special mention should be made of the organization and direction of Latin-American studies including agriculture at the *University of Florida, Louisiana State University* and *Texas A. & M.* At Florida a special, much needed type of agricultural scholarship has been set up, of which there is need for many. This was established by DAVID BURPEE of Philadelphia, and provides one to two years of training in practical horticulture for at least one student a year from Latin America. This scholarship is not intended to lead to a degree, but to give training in practical horticultural techniques of immediate application to tropical problems.

At *Iowa State College* ten graduate fellowships have been made available in agriculture, with traveling expenses provided by the Department of State.

Twenty scholarships for two years each, were provided by the *Columbia Foundation of San Francisco* for Latin-American students in Agriculture, all for the two year terminal course in agriculture at the College of Agriculture, University of California, at Davis. The entry of the United States into this war and the taking over of the teaching facilities of this campus entirely for military instruction, interrupted the program after applications had been received. Other institutions faced similar disturbances of their programs similar in character. The importance of training in practical agricultural techniques below the level of a four year degree course has been recognized by all who are working in this field. It offers one of the means of immediate practical help.

The importance of forestry and conservation in Latin-American development has been recognized by the *University of Michigan School of Forestry*, where ten graduate fellowships in these fields have been made available, and an effort is being made to carry them out even under the handicaps of the war.

The *Catholic Bureau of Inter-American Collaboration*, connected with the Department of Education of the National Catholic Welfare Conference has offered scholarships to men and women in various fields of study including agriculture.

Still another type of training in rural leadership is exemplified in the "internships" provided under the auspices of the *Rural Electrification Administration*, beginning in 1941. Under these arrangements qualified young engineers from Latin-American countries have been brought to the United States to learn new techniques in the application of electricity to agriculture, to visit equipment factories, and make field surveys under competent direction.

The picture here given is in no way complete or comprehensive. It has been sketched in to indicate the importance scholarships and fellowships should play in developing inter-American relationships in agriculture, and various programs already under way when war interrupted. It is anticipated that most, if not all, of these activities will be carried on with renewed vigor and expansion when peace comes.

The war also abruptly interrupted the start in sending students of the United States to Latin-American institutions, an equally important part of the program. The numbers of agricultural institutions available for study by United States students is not as large as in this country, but the advantages of those available cannot be fully utilized until the study of languages becomes more common than at present in the United States. The language problem is one of the prime limiting factors in both faculty and student exchange in all the countries of the hemisphere. Until widespread use of Spanish, Portuguese and English is common practice, any program for a greatly enlarged use of scholarships and fellowships will be hampered. One of the most valuable lessons of the war has been that which emphasizes the necessity of language study as a primary objective of American youth. The post-war carry over of this emphasis should be of material aid in the Latin-American field.

The use of scholarships and fellowships is but one of several fundamental methods for improving and cementing permanent inter-American understanding and friendship. It is not spectacular but is a steady cumulative influence expanding through the years. It is tried and proven, and it is hoped the post-war era will see greatly increased support for all fields, of training, of which agriculture will always be of first importance.

COLLEGE OF AGRICULTURE OF THE UNIV. OF CALIFORNIA. BERKLEY, CALIF.

PAUL L. GUEST: **Some of the Principal Latin American Plant Science Periodicals:** — The value of an extensive literature to investigators in any field of activity is commonly recognized. With increased activity being displayed in plant science in the other American republics, especially by North American workers, considerable attention has been focused upon the agricultural and plant science literature from those countries.

The purely scientific material from Latin America is not overly abundant, but there is a wealth of information in numerous periodicals which have been or are being published. As an index of the extent of these publications, it is interesting to note that the library of the United States Department of Agriculture has a collection of more than 1000 agricultural and biological periodicals and serials from the Western Hemisphere exclusive of Canada and the United States.* However, many of these consist of only one volume while others, issued over a period of a few years, are no longer current. Some of these periodicals place emphasis upon single crops or subjects such as coffee, sugarcane, cotton, tobacco, and irrigation. A number have been published continuously for more than 25 years and a few for over 50 years. Although many of the articles and papers merely present, in Spanish or Portuguese, material apparently based upon articles in North American and European periodicals, nevertheless, considerable original work is also published. Much of the information reported is written in a practical vein and deals with tillage problems of the particular country or region in which the periodical is published. However, some of the plant science journals from the other American republics are published in excellent form and compare favorably with leading journals throughout the world. In general, the subscription price is in keeping with the general economic level of the country in which the periodical is published. The publications mentioned in this article are issued currently or at least were current as late as 1940.

Many of the principal journals which deal with papers of a more technical, fundamental, or academic nature are published in Argentina. *Agronomia, Organo Oficial del Centro Estudiantes de Agronomia*, Buenos Aires, has been published at irregular intervals of approximately three to 13 months since 1908, and contains articles on soils and veterinary science as well as

* "A Preliminary List of Latin American Periodicals and Serials," U. S. Dep't. of Agr. Library List No. 5, Washington, D. C., 1943.—Cf. also "Journals dealing with the Natural, Physical and Mathematical Sciences published in Latin America," Panamerican Union, Washington, D. C., 1944, and a few lists referred to in CHRON. BOT. 7: 93/94.

plant science. The *Notas del Museo de la Plata (Botánica)*, *Revista del Museo de la Plata (Nueva serie)*, and the *Revista de la Facultad de Agronomía* are all published by the *Universidad Nacional de la Plata, La Plata, Argentina.* The *Notas* and *Revista del Museo* are issued at irregular intervals and report work done in botany. The *Revista de la Facultad de Agronomía* is an annual which has been published since 1895. Each volume contains up to approximately 300 pages and presents from 5 to 12 papers with summaries in Spanish, English, French, German, or Italian. The *Revista Argentina de Agronomía,* Buenos Aires, is a quarterly in which some articles are accompanied by Spanish, English, or French summaries. Ten volumes of another principal plant science journal, the *Revista de la Facultad de Agronomía Veterinaria, Universidad de Buenos Aires,* have appeared since it was first issued in 1917. The *Estación Experimental Agrícola de la Provincia de Tucumán,* Tucumán, Argentina, for 33 years has published a quarterly, the *Revista Industrial y Agrícola de Tucumán,* which includes papers on various economic plants, entomology, and related subjects.

A number of leading journals are also found outside of Argentina. The *Arquivos do Instituto Biologico,* São Paulo, Brazil, is an annual which covers both plant and animal science. Articles are written in Portuguese, German, or English, with abstracts or summaries in any one of these three languages. This same *Instituto* also issues a monthly, *O Biológico.* The *Escola Superior de Agricultura* at Viçosa, Minas Gerais, Brazil, founded a bi-monthly journal called *Ceres* in 1939. In addition to original articles on plant and animal science, each issue also carries abstracts in Portuguese of as many as 30 or more articles from agricultural publications issued in various parts of the world. The *Jardim Botanico,* Rio de Janeiro, Brazil, has printed a quarterly botanical journal, *Rodriguesia,* for several years. In Bogotá, Colombia, the *Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales* carries articles on botany, entomology, and natural history in general. It is one of the newer journals, having appeared quarterly to semi-annually since 1936. The papers are illustrated by colored plates, graphs, and figures. *D.N.A.,* from San José, Costa Rica, and a new bi-monthly called *Fitofilo,* from Mexico City, Mexico, also present technical plant science material. Crop field trials, statistical analyses and a wide variety of plant science articles appear in the *Revista de la Facultad de Agronomía, Universidad de la República,* Montevideo, Uruguay, which is published at irregular intervals of approximately 3 to 6 months.

*Tropical Agriculture,* a monthly *Journal of the Imperial College of Tropical Agriculture,* St. Augustine, Trinidad, is one of the principal English plant science periodicals in Latin America. The *Annual Report on Cacao Research,* also issued by the Imperial College, contains excellent technical papers on cacao. From 1932 to 1940, the *Department of Science and Agriculture,* Barbados, issued a quarterly, the *Agricultural Journal,* which reported investigations carried on in plant, soil, and related sciences.

In addition to the above periodicals, many others occasionally present excellent articles in the general field of plant science. The annual *Boletim de Agricultura,* issued since 1900 by the *Directoria de Publicidade Agricola,* São Paulo, Brazil, falls in this category. The *Boletim do Ministerio da Agricultura,* Rio de Janeiro, Brazil, which has been published approximately monthly since 1912, deals mainly with articles on legislation and administration, but technical papers in plant science appear occasionally. For more than 45 years the *Sociedade Nacional de Agricultura,* Rio de Janeiro, Brazil, has printed a monthly, *A Lavoura,* which contains scientific information as well as notes of the society. These Brazilian periodicals, of course, are in Portuguese. The *Revista de Agricultura, Organo Oficial del Ministerio de Agricultura,* Havana, Cuba, from time to time presents technical material although much of the subject matter deals with crop practices and other items. The *Secretaría de Agricultura,* Guatemala City, Guatemala, issues a monthly *Revista Agrícola* which carries articles covering experimentation on cultural methods, fertilization, etc. The monthly *Boletín Mensual* of the *Junta Nacional del Algodón, Ministerio de Agricultura,* Buenos Aires, Argentina, contains scientific papers on cotton culture in addition to statistics on cotton production and prices. A monthly journal, *La Industria Azucarera,* Buenos Aires, Argentina, which has been printed since about 1899, includes technical information on sugarcane and other crops although it deals primarily with the commercial aspects of sugarcane production. *Irrigación en México* is published bi-monthly by the *Comisión Nacional de Irrigación,* Mexico City. It is largely an industrial or construction irrigation journal but occasionally it reports work done on soils or in plant science with reference to irrigation.

Some of the periodicals mentioned above, as well as a number of others in Latin America, contain articles which are somewhat similar in style and subject matter to the Farmers Bulletins and Circulars of the United States Department of Agriculture. The *Revista Nacional de Agricultura,* published monthly since 1906 by the *Sociedad de Agricultura de Colombia,* Bogotá, Colombia, falls in this class. There is also the *Revista Cafetera de Colombia,* Bogotá, Colombia, which deals mainly with coffee culture and the monthly *Anales* of the *Sociedad Rural Argentina,* Buenos Aires, which has been issued since 1866. A great deal of the subject matter in the latter pertains to livestock but a few general articles on farm crops also appear. *GEO,* from La Paz, Bolivia, and *La Tierra,* from Mexico City, Mexico, also are monthly periodicals of this same general type. *México Forestal* is a monthly forestry journal published in Mexico City for more than 20 years. *The Journal of the Jamaican Agricultural Society,* Kingston, Jamaica, which has been printed monthly since 1897, includes short articles on plant diseases, fertilization, and crop culture. The *Proceedings of The Agricultural Society of Trinidad & Tobago,* Port-of-Spain, Trinidad, published quarterly for almost 50 years, contains much material that is not closely related to plant science, but a few pages of each issue are devoted to nontechnical articles on plant diseases, entomology, and cultural practices. The agricultural experiment stations in several of the other American republics also issue agricultural and plant science bulletins somewhat similar to those published by the State agricultural experiment stations in the United States.

A great number of general farm magazines

along the lines of the *Country Gentleman*, or *The Prairie Farmer* in the United States are published throughout Latin America. Almost all of the other 20 American republics have one or more magazines of this type. Some of these are excellent and from time to time carry technical plant science articles. *La Chacra* and the *Revista Mensual B. A. P.*, both published monthly in Buenos Aires, Argentina, fall in this category. *O Campo*, from Rio de Janeiro, *Chacaras e Quintais*, *Revista Rural Brasileira*, and *Sitios e Fazendas*, from São Paulo, Brazil, are farm monthlies of this general class. Another is *El Campesino*, a monthly from Santiago, Chile, published since 1869 by the *Sociedad Nacional de Agricultura*. The *Revista de Agricultura* is a general farm magazine which appears monthly in San José, Costa Rica. *La Vida Agrícola*, Lima, Peru, issued for almost 20 years, and *La Propaganda Rural*, founded in Montevideo, Uruguay in 1902, are two other monthly magazines of this type. The *Asociación Rural del Uruguay*, Montevideo, Uruguay, has printed a monthly *Revista* since about 1871. Many of the articles in some of these periodicals appear to be based on material previously published in North American farm journals or bulletins although, of course, a great deal of original material on local crop practices, pest control, poultry, and livestock, is also presented.

The relatively few publications which have been mentioned by no means exhaust the supply of the more outstanding, current Latin American plant science periodicals. Rather, they serve as examples of literature of this type published in the Western Hemisphere, exclusive of the United States and Canada.

### Some of the principal Latin American Plant Science Periodicals

**— Argentine —**

*Agronomía* (Centro Estudiantes de Agronomía, Buenos Aires)
*Anales de Farmacia y Bioquímica* (Buenos Aires)
*Anales de la Sociedad Rural Argentina* (Buenos Aires)
*Boletín Mensual de la Junta Nacional del Algodón* (Buenos Aires)
*La Chacra* (Buenos Aires)
*Darwiniana*, Revista del Instituto de Botánica "Darwinion" (San Isidro, F.C.C.A.)
*La Industria Azucarera*, Revista Mensual (Centro Azucarero Argentino, Buenos Aires)
*Lilloa*, Revista de Botánica (Instituto "Miguel Lillo," Tucumán)
*Notas del Museo de La Plata, Botánica* (La Plata).
*Physis*, Revista de la Sociedad Argentina de Ciencias Naturales (Buenos Aires)
*Revista Argentina de Agronomía* (Sociedad Arg. de Agronomía, Buenos Aires)
*Revista de la Facultad de Agronomía y Veterinaria* (Buenos Aires)
*Revista de la Facultad de Agronomía* (Universidad Nacional de La Plata)
*Revista Industrial y Agrícola de Tucumán* (Estación Experimental Agrícola de la Provincia de Tucumán, Tucumán)
*Revista Mensual B.A.P.* (Buenos Aires)
*Revista del Museo de La Plata* (La Plata)
*Trabajos del Instituto Nacional de Botánica y Farmacología "Julio A. Roca"* (Buenos Aires)

**— Barbados —**

*Agricultural Journal* (Dept. of Science and Agriculture, Barbados)

**— Bolivia —**

*GEO* (La Paz)
*Revista de Agricultura* (Cochabamba).

**— Brazil —**

*Arquivo do Serviço Florestal* (Rio de Janeiro)
*Arquivos de Botânica do Estado de São Paulo* (Secretaria da Agricultura, Indústria e Comércio de São Paulo)
*Arquivos do Instituto Biológico* (São Paulo)
*Arquivos do Instituto de Pesquisas Agronômicas* (Pernambuco)
*O Biológico* (Instituto Biológico, São Paulo)
*Boletim de Agricultura* (São Paulo)
*Boletim da Faculdade de Philosophia, Sciencias e Letras, Botânica* (Universidade de São Paulo)
*Boletim, Inspetoria Federal de Obras contra as Sêcas* (Ministerio da Viação e Obras Públicas, Rio de Janeiro)
*Boletim do Ministério da Agricultura* (Rio de Janeiro)
*Boletim do Museu Nacional* (Rio de Janeiro)
*Boletim da Sociedade Brasileira de Agronomia* (Rio de Janeiro)
*Bragantia*, Boletim Técnico do Instituto Agronômico do Estado de São Paulo (Campinas, Est. de São Paulo)
*Brasil Açucareiro* (Instituto do Açucar e do Alcool, Rio de Janeiro)
*O Campo*, Revista Mensal de Lavoura, Pecuaria e Indústrias Rurais (Rio de Janeiro)
*Ceres* (Viçosa, Minas Gerais)
*Chacaras e Quintais* (São Paulo)
*Jornal de Agronomia* (Sindicato Agronômico do Estado, Piracicaba, Est. de São Paulo)
*A Lavoura*, Boletim Mensal da Sociedade Nacional de Agricultura e da Confederação Rural Brasileira (Rio de Janeiro)
*Revista de Agricultura* (Piracicaba, Est. de São Paulo)
*Revista Agronômica* (Sindicato Agronômico do Rio Grande do Sul, Porto Alegre)
*Revista da Flora Medicinal*, Revista de Propaganda das Riquezas Naturais do Brazil (Rio de Janeiro)
*Revista do Instituto do Café do Est. de São Paulo* (São Paulo)
*Revista de Química e Farmacia* (Rio de Janeiro)
*Revista Rural Brasileiro* (Sociedade Rural Brasileira, São Paulo)
*Rodriguesia* (Rio de Janeiro)
*Sitios e Fazendas* (São Paulo)

**— Chile —**

*Boletín del Ministerio de Agricultura* (Santiago)
*El Campesino* (Santiago)
*Revista Chilena de Historia Natural pura y aplicada* (Santiago)

**— Colombia —**

*Agricultura y Ganadería* (Departamentos de Agricultura y Ganadería, Ministerio de la Economía Nacional, Bogotá)
*Caldasia*, Boletín del Instituto de Ciencias Naturales de la Universidad Nacional de Colombia (Bogotá)
*Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales* (Bogotá)
*Revista Cafetera de Colombia* (Bogotá)
*Revista de la Facultad Nacional de Agronomía* (Medellín)
*Revista Nacional de Agricultura* (Sociedad de Agricultores de Colombia, Bogotá)

**— Costa Rica —**

*D.N.A.* (San José)
*Revista de Agricultura* (San José)

**— Cuba —**

*Agronomía*, Revista mensual de Agricultura Científica (Sociedad Cubana de Agrónomos y Químicos, Habana)
*Memorias de la Sociedad Cubana de Historia Natural* (Habana)
*Revista de Agricultura* (Junta Provincial de Agricultura de la Habana, Habana)

— Domingo —

*Revista de Agricultura* (Secretaria do Estado de Agricultura, Industria y Trabajo)

— Ecuador —

*Flora,* Revista de Botánica y Farmacognosía (Instituto Botánico, Facultad de Ciencias, Universidad Central, Quito)

— Guatemala —

*Revista Agrícola* (Secretaria de Agricultura, Guatemala City)

— Jamaica —

*The Journal of the Jamaican Agricultural Society* (Kingston)

— Mexico —

*Agrícola,* Revista Quincenal de Agricultura y Ganadería (México, D.F.)
*El Agricultor Mexicano* (Cindad Juárez, Chih.)
*Agricultura y Ganadería* (México, D.F.)
*Anales de la Escuela Nacional de Ciencias Biológicas* (México, D.F.)
*Anales del Instituto de Biología* (Chapultepec, D. F.)
*Boletín Forestal y de Caza* (Dirección Forestal y de Caza, México, D.F.)
*Ciencia,* Revista Hispano-Americano de Ciencias puras y aplicadas (México, D.F.)
*Fitófilo* (México, D.F.)
*Irrigación en México* (México, D.F.)
*México Forestal* (México, D.F.)
*Revista de la Sociedad Mexicana de Historia Natural* (México, D.F.)
*La Tierra* (México, D.F.)

—Nicaragua —

*Revista Agrícola* (Asociación Agrícola de Nicaragua, Managúa)

— Paraguay —

*Cartilla de Propaganda Agro-Pecuaria* (Ministerio de Economía, Asunción)

— Peru —

*Agronomía* (Centro de Estudiantes de Agronomía, Lima)
*Boletín de la Dirección de Agricultura y Ganadería* (Lima)
*La Vida Agrícola* (Lima)

— Puerto Rico —

*The Journal of Agriculture of the University of Puerto Rico* (Rio Piedras)

— Trinidad —

*Annual Report on Cacao Research* (Imperial College of Tropical Agriculture, St. Augustine)
*Proceedings of the Agricultural Society of Trinidad and Tobago* (Port of Spain)
*Tropical Agriculture* (Imperial College of Tropical Agriculture, St. Augustine)

— Uruguay —

*Anales del Museo de Historia Natural de Montevideo* (Montevideo)
*Archivo Fitotécnico del Uruguay* (Instituto Fitotécnico y Semillero Nacional "La Estanzuela," La Estanzuela, Depto. Colonia)
*La Propaganda Rural* (Montevideo)
*Revista de la Asociación de Ingenieros Agrónomos* (Montevideo)
*Revista de la Asociación Rural del Uruguay* (Montevideo)
*Revista de la Facultad de Agronomía* (Montevideo)
*Revista Sudamericana de Botánica* (Asociación Sudamericana de Botánica, Montevideo)

— Venezuela —

*Boletín de la Sociedad Venezolana de Ciencias Naturales* (Caracas)

No discrimination is implied and no endorsement on the part of the United States Department of Agriculture is given in this article.

OFFICE OF THE AGRICULTURAL ADVISER,
EMBASSY OF THE U.S.A.,
SANTIAGO DE CHILE.

LAWRENCE W. WITT: **Coöperative Agricultural Research and Extension Stations in Latin America:** — More knowledge of the economic vegetation and other agricultural resources of the Western Hemisphere and the most appropriate method of utilizing them is being obtained through the program of the United States Department of Agriculture by the organization of coöperative research and extension centers in Latin America. Through these stations agriculturists in the coöperating Republics are working jointly with North American technicians to increase the scientific knowledge and skills of the actual producers. Efforts are concentrated on products which complement those of the United States, such as rubber, quinine, rotenone, pyrethrum and other insecticides, fibers other than cotton, cacao, certain vegetable oils and drug plants. Assistance is given coöperating countries with food crops and livestock where necessary to provide adequate food supplies in the areas where complementary products are being produced.

As improved techniques must be developed from the study of specific problems as they arise in differing geographical and cultural environments, and since there are great disparities in the amount of study given to the problems in differing climates and regions, up-to-date information and technique vary sharply from one area of the world to another. Consequently, technically trained men must be sent from the more advanced areas to the less advanced areas if the maximum exploitation of the agricultural resources of the hemisphere is to be attained.

This flow of skills has occurred in the past in several different ways. The most common has been the contracting by private citizens, government agencies or educational institutions for the services of individuals. More direct assistance was inaugurated several years ago when provision was made for inter-governmental borrowing of personnel on a reimbursable basis. Under this program many North American scientists have been lent to other American Republics with the borrowing government paying their salaries, or expenses or both. Under the present program of joint development of research centers and extension education, the procedures have been broadened so that more positive implementation of the effort to improve the economic status of neighboring countries will add to the supply of strategic commodities for war and contribute to a profitable commerce in time of peace.

As early as 1936, consideration was given to the possibilities of aiding in the production of strategic complementary products in the other American Republics. When funds were appropriated in 1940, active work was begun. The work proceeded in three stages. The first step consisted of surveys in various countries to obtain basic information. The second step was the negotiation of ten-year agreements between the Dept. of Agriculture through the Office of Foreign Agricultural Relations and the corresponding agencies of other governments for the establishment and operation of coöperative agricultural experiment stations and related activities. The third and present stage is active research and education in plant disease and insect control, plant breeding, production practices, and, in general, the ways and means of increasing the economic production, handling and marketing of the farm products which complement

those of the United States and which are adapted to the country.

The first agreement was signed with Peru on April 22, 1942 for the establishment of a station at Tingo María on the eastern slopes of the Andes about 2,200 feet above sea level. Under terms of the agreement the United States supplies North American scientists, scientific equipment not manufactured in Peru, scientific journals and certain other materials. The Peruvian Government supplies associate scientists to work with the North Americans, land, residences, station buildings, skilled and unskilled labor, an adequate water supply, medical services, transportation within Peru and similar items. [Similar agreements have been signed with Nicaragua (July 15, 1942), El Salvador (October 21, 1942), Ecuador (August 12, 1942) and Guatemala (July 15, 1944).* Personnel are coöperating with existing agricultural institutions in Cuba, Brazil, Colombia, Costa Rica and Honduras.]

A number of the countries are making plans for the establishment of agricultural schools at the sites of the coöperative experiment stations. The coöperative work of nationals of the several countries already provides intern-training in the United States for some of the personnel. Collections are being made of botanical, entomological and zoological specimens, and a small reference library for the use of technical personnel has been established at each coöperative experiment station. Numerous research projects are under way and others are rapidly taking form.

Results of these activities are becoming visible. First, and of prime importance for war purposes, production is under way of complementary commodities formerly obtained mainly from areas now controlled by the Axis powers. For example, nearly 50,000 cinchona seedlings have been sent to Peru and an equal number to Ecuador for commercial plantations, while lesser numbers have been sent to other countries for experimental purposes. Research in cinchona disease problems in Bolivia has provided information which should materially lessen the incidence of disease and increase future production. Derris cuttings have been sent from the U. S. D. A. Station at Mayagüez, Puerto Rico, to several of the other American republics. Included are 250,000 cuttings sent to Ecuador and smaller quantities to other countries. Agronomic research and extension activities have materially aided Peruvian and Brazilian producers of rotenone in the Amazon Basin. Experimental work in agronomic and mechanical phases of producing roselle fiber are under way in Cuba and show promise of providing a technical basis for greater production of this crop.

A result, more intangible but nevertheless significant, is the greater understanding among the leaders in the several countries, both scientific and political, which comes about through association in the solution of common problems, in sharing the work incident to the development of latent resources, in furthering a joint war effort, and in the creation of a better world.

OFFICE OF FOREIGN AGRICULTURAL RELATIONS,
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

* For more detail see article by Dr. Ross E. Moore in *Agriculture in the Americas* June 1943 issue.

WILLIAM CROCKER: **The Tropical Plant Research Foundation Inc.:** — The Board of Trustees of Tropical Plant Research Foundation met in Washington, D. C., on May 21, 1943, for the purpose of dissolving the Foundation and distributing the assets of the Foundation to other organizations that are now carrying forward the avowed functions of the Foundation. They also authorized and directed the officers of the corporation to institute proceedings in the United States District Court of the District of Columbia for the dissolution of this corporation as allowed and provided by law.

The distribution of assets were as follows: (1) The Tropical Agriculture Library now housed at Boyce Thompson Institute, including all copyrights, was given to the Inter-American Institute of Agricultural Sciences of Turrialba, Costa Rica. This is to be dedicated and marked with an appropriate plaque as a memorial to Doctor W. A. ORTON, the organizer and director and general manager of the Foundation from its inception in 1924 until his death in 1930. (2) Fifty copies of *The Soils of Cuba,* including the accompanying maps, were given to each of the joint authors, Mr. H. H. BENNETT and Dr. R. V. ALLISON. Fifty copies of *Tropical Forests of the Caribbean* were given to the author, Mr. TOM GILL. The remaining copies of these books, about 550 of the former and about 225 of the latter, were turned over to the Pan American Union to be advertised and sold. The returns from these sales are to be turned over to the Division of Biology and Agriculture of the National Research Council or to some other appropriate organization to be used to further tropical agriculture. (3) All residual cash and bonds, after payment of debts and expenses of dissolution, were given to the Division of Biology and Agriculture of the National Research Council to be used for the promotion of tropical agriculture. This contribution will net more than $4,000. (4) The furniture, book cases, steel cabinets, etc., are left at Boyce Thompson Institute for Plant Research, Inc., Yonkers, N. Y., in appreciation of services rendered the Foundation during the period following Doctor ORTON's death.

The purposes, method of administration, and financing of the Foundation while it was in operation are described by the following three quotations from "Tropical Plant Research Foundation — Objects and Character — Jan. 12, 1931":

"The objects of the Foundation are to promote research for the advancement of knowledge regarding the plants and crops of the tropics. It conducts investigations on plant diseases and insects, on soils, on the varieties of crop plants and their improvement by breeding, and on other subjects pertaining to agronomy, horticulture, plant physiology, and forestry, and publishes the results.

"The administration of the Foundation is vested in a board of ten trustees, of whom six represent certain divisions of science included in the Foundation's field work and four represent tropical American business and philanthropical interests.

"The work of the Foundation is supported by funds contributed by organizations, governments, and individuals, which desire to avail themselves of the scientific service offered or to assist in furthering the work it is doing. Each

project is outlined in detail and approved by the Board of Trustees, then submitted with a proposed budget to the National Research Council for approval. The funds of the Foundation are received and invested by the National Research Council and paid over to the Treasurer of the Foundation as needed for current expenses. The accounts are audited annually under the direction of the Council. The Foundation does not as yet have a capital fund, but maintains its central office from an overhead allowance of 20 per cent of its appropriation for special projects, all of which is needed for expenditure in the interest of these researches, leaving nothing for the general work for the development of tropical science or for the preliminary survey studies and planning of new research projects."

Some time after this date all fiscal affairs and management of the Foundation were turned back to the Board of Trustees of the Foundation by the National Research Council.

For six years, 1924-1930, the Foundation conducted a sugar experiment station at Baragua, Cuba, with an annual budget of $100,000, notably advancing work upon many insect, disease, and cultural problems in sugar production of Cuba. These researches were published in thirty-two different Bulletins and Scientific Contributions, mainly in English but some in Spanish. Copies of all but a few of these still remain in the library given to the Inter-American Institute. The Foundation obtained money for a detailed survey of the soils of Cuba by H. H. BENNETT and R. V. ALLISON. This resulted in a 410-page volume with a large soils map of Cuba. Other tropical American countries would be greatly benefited by a similar survey. The Foundation made a forestry survey of Cuba supported by the United Fruit Company, also a survey of the forests of the Caribbean region. The latter culminated in a 310-page book by TOM GILL, entitled *Tropical Forests of the Caribbean*. This survey was supported by the Charles Lathrop Pack Forestry Foundation. Doctor ORTON visited Brazil to study the forestry research and administration needs of that country. With aid from Professor D. M. MATTHEWS of University of Michigan and other forestry experts he outlined a forestry service for Brazil which that country later adopted. He later aided them in selecting the personnel for the service. A survey was made of the coastal region of Peru and an agricultural experiment station planned for them to deal with problems of sugar cane and cotton production. In 1927 the Chicle Development Company financed a study of the sapota tree under the direction and active participation of Dr. J. S. KARLING of Columbia University. This study continued for several years and resulted in a number of publications on the histology, cytology, and physiology relating to bark structure and latex formation. This study led to the recommendation of a new method of tapping which is more effective and less injurious to the trees than the method in use.

During the entire period of its activity the Foundation maintained advisory relations with government and private agencies interested in tropical agriculture of Latin America and during the later years of his life Doctor ORTON served the Pan American Union on part time as its agricultural adviser. After Doctor ORTON's death, Doctor J. L. COLOM became Chief of the Division of Agriculture of the Union and continued the work that Doctor ORTON had started. The activities of both men have done much to advance tropical agriculture. The Inter-American Institute of Agricultural Sciences, which promises to serve agriculture in a bigger and more effective way than the Foundation was able to do, may be considered an outgrowth of the advisory service of the two men. Doctor ORTON's advisory service furthered tropical agriculture in many other directions. Through advisory activity the Foundation may have contributed more in advancing agricultural science than it did through the specific projects described above. In any case, Doctor ORTON and the Foundation were pioneers in promoting tropical agricultural science in America.

Because of this the following wording was placed on a plaque at the Orton Memorial Library:

ORTON MEMORIAL LIBRARY
PRESENTED APRIL 21, 1943
*to*
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*In Memory Of*
DR. WILLIAM ALLEN ORTON
WHOSE DEVOTION AS DIRECTOR OF THE FOUNDATION WAS AN INSPIRATION IN THE DEVELOPMENT OF LATIN AMERICAN AGRICULTURE AND FORESTRY

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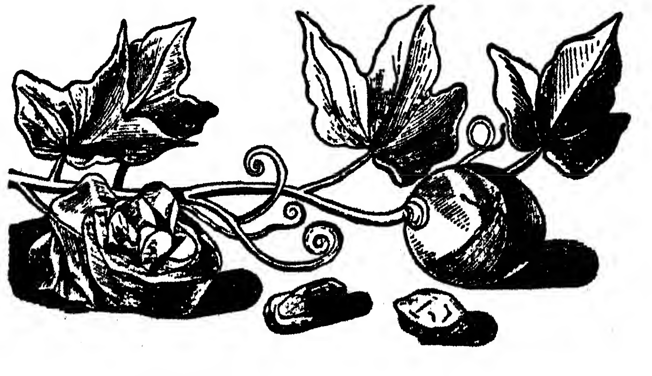

*Special Supplement*

# PLANT BREEDING, GENETICS AND CYTOLOGY IN LATIN AMERICA

*by*

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**Introduction:** — A glance at the map of the Western Hemisphere convinces us that Latin America covers an enormous territory. It extends from 33° N to 50° S of the equator; its altitude varies from sea level to over 7,000 meters in the Andes. Because of these variations in latitude and altitude, every sort of climate can be found, from the moist, hot tropics of the Amazon basin to the extreme cold of the snow-covered mountains of the Andes. Consequently, the native floras offer tremendous diversity to the botanist who travels through Central and South America, overwhelming him with its abundance in the moist and hot regions and fascinating him with thousands of representatives in other specific ecological zones, such as the desert climate of northeast Brazil, the Pampas of the Argentine, or the Andean slopes of the Pacific coast.

Latin America is extremely rich in wild species of many of our cultivated plants: potatoes, beans, tobacco, manioc, etc. It is the center of origin of one of our most important cereals: *Zea mays*. Quinine (*Cinchona*) and rubber (*Hevea*) are native to South America, and many other economic plants (medicinals — fibers — stimulants, etc.) still grow wild in many regions.

Another consequence of the great variability of the climate is the diversity of its agriculture. Doubtless, every single economic plant can be grown successfully in some part of its territory: wheat, grapes, peaches, etc. in its temperate zones; and rubber, bananas, coffee, etc. in its tropical and subtropical regions. However, modern agriculture, with a few exceptions, is still in its infancy, but rapid progress is being made in several countries toward modernising agricultural industries: schools and experiment stations are being established; specialists in various fields are being brought in from other countries; young scientists are being trained abroad; and reciprocity between Latin America and the United States is increasing.

This short introduction should be sufficient to point out what an enormous wealth of material is available to the plant breeder, geneticist, and cytologist in Latin America. To these scientists the field is almost virgin, having scarcely been touched in some countries, as this article will explain.

The following chapters give a comprehensive survey of what has so far been done, in the Latin American republics and other countries in plant breeding, genetics, and cytology. Besides reviewing the available literature, the author has corresponded with leading specialists in these fields in order to collect as much additional information as possible. He does not claim to have covered the field completely, because the literature is scattered through a large number of local journals of very limited circulation, and many articles have been published abroad in American, British, and German periodicals. In various instances, correspondence has, unfortunately, failed to provide the desired information.

In order to simplify the presentation of the subject, each country is considered separately. first those of South America, then those of Central America, and finally the West Indies.

## South America

**Argentine:** — Without doubt, Argentina is one of the most progressive countries of South America. For the most part, the climate is mild and temperate, and consequently favorable to European colonization. Except in the west, it is a vast plain which man has easily colonized and across which he has built railroads and highways. Its agriculture is limited to a few important crop plants, but these are grown extensively. They are mainly wheat, maize, and lately also cotton on the low lands; temperate fruits in the western hilly regions; and sugar cane, citrus fruits, etc. in the northwest.

The institutions where research in plant breeding, genetics, and cytology is conducted are under the supervision either of the Ministerio de Agricultura de la Nación, or of various universities and municipalities (provincias) or are private organizations devoted to the production and distribution of selected seeds. Certain industries — for instance, sugar-cane growing — also finance breeding work at various institutions. Perhaps Argentina is also the only country in Latin America where several railroad companies maintain experimental stations for research work on economic plants.

In the "Dirección de Agricultura" of the Ministerio de Agricultura two important divisions work in plant breeding.

(1) *División de Estaciones Experimentales.* — At six of its experiment stations, located in various parts of the country (Entre Rios, San Juan, Rio Negro, Misiones, Salta, and Santa Cruz), work to improve a great variety of crop plants, such as *Citrus* and other fruit plants, forage crops, mate (*Ilex paraguayensis*), and several forest species, is being carried on.

(2) *División Producción de Granos* (Grain Production Division). — This Division was organised in 1937 in order to supervise the whole grain industry in the country. Under its direction the following six experiment stations are working with various cereal plants:

Pergamino (B.A.): maize, flax, wheat, sunflower, oats and barley
Guatraché (La Pampa): wheat and barley

Rafaela (Santa Fé): wheat, flax and maize
Alberdi (Entre Ríos): flax and wheat
Manfredi (Córdoba): wheat and maize
Güemes (Salta): rice.

To this Division also belong the office of Certified Seed Registration (Registro Oficial de Semillas Fiscalizadas), the office for the Inspection of Seed Enterprises, and a central laboratory for milling and baking tests. A new variety of any of the above-named crop plants cannot be introduced to the farmers until it has been sufficiently tested by the Ministerio de Agricultura. Besides high yielding capacity, the new variety must also furnish a product of good quality. A special committee (Tribunal de Fiscalización de Semillas), composed of various representatives of the Ministerio de Agricultura, of the Grain and Elevator Commission, and of the private seed companies devoted to plant breeding, is in charge of the study of each new variety and make final decisions regarding its distribution to the farmers.

Of the experiment stations which have been mentioned, the following deserves special attention:

*Estación Exp. de Pergamino.* — Director: WALTER F. KUGLER; Assistants: JUAN A. ETCHECOPAR, H. R. BATALLÁNEZ, CASTULO CIALZETA, NOÉ HOROVITZ. Breeding work is done with the following plants:

*Oil flax.* — The main object is to produce varieties which yield a maximum quantity and the best possible quality of oil and which are resistant to three diseases: mainly to "pasmo," caused by *Septoria linicola*, and to "roya," caused by *Melampsora lini*.

*Fiber flax.* — The improvement of several varieties was begun about five years ago in order to avoid the future introduction from abroad of seed susceptible to the two above-named diseases. This year (1943) seed of the first improved variety bred in this country was sold to the farmers.

All improvement work is done in coöperation with a Plant Pathology and a Fiber Technology Laboratory. The first is under the supervision of the Dirección de Sanidad Vegetal del Ministerio de Agricultura, ERNESTO F. GODOY in charge. This laboratory does extensive research on the principal diseases of cereals and flax, particularly rusts, smut, and septoriosis (*Septoria nodorum* and *S. tritici*) of wheat, and on wilts and rusts of flax.

*Maize.* — A new project to obtain inbred lines to be used for commercial hybrid seed production has recently been started.

*Sunflower.* — As the cultivation of this oil plant is constantly increasing in various parts of the Argentine, a new breeding program to improve local varieties has recently been established. In connection with this project research on flower biology and other related aspects is also being conducted.

*Wheat.* — Many varieties are grown every year and crosses are made to study the inheritance of several characters.

Besides their breeding and genetical work, most of the members of the staff also do taxonomic research to identify new varieties of crop plants which are to be introduced to the farmers.

Under the supervision of the Dirección de Agricultura we find the following organizations dealing with the improvement of crop plants:

(a) *Servicio Fitotécnico de la Papa* (Potato Division). — This division was organised in 1942 and is partially financed by a tax on the potato industry. It expects to do research on various aspects of potato cultivation, including problems related to seed production in the Argentine. So far it has only one experiment station located at Balcarce, F.C.S., close to Buenos Aires.

(b) *Junta Nacional del Algodón.* — This institution was founded by the government in 1935 to supervise the new and promising cotton industry of the country. It is maintained by a special cotton tax and is an autonomous organization. It does research on cotton breeding and on all agronomic problems of this crop plant, for it is also in charge of extension work and seed distribution. Six experiment stations are under its supervision: two in the Chaco, two at Santiago del Estero, and one each at Formosa and Santa Fé.

It publishes a monthly bulletin in which a detailed account of its work is given.

(c) *Instituto Nacional del Tabaco.* — Similar to the Junta Nacional del Algodón, this institution was recently organised by the government to coordinate all work related to tobacco growing and manufacturing in the country. It has four experiment stations, at Misiones, Salta, Tucumán and Corrientes, respectively, and two sub-stations at Córdoba and Jujuy. At these institutions various breeding projects have been planned.

We find research on plant breeding, genetics, and cytology in the following Argentine universities:

(a) *Facultad de Agronomía de la Universidad de la Plata.* — Here extensive rice breeding experiments have been conducted lately, and in one of its specialized laboratories research is being done on the quality of grains produced in various parts of the country.

Special mention should be made of the *Instituto Fitotécnico de Santa Catalina* at Llavallol, which, under the efficient direction of S. HOROVITZ, is doing perhaps the best work on plant genetics and cytology in the Argentine. This research institution devotes itself particularly to the following plants:

*Maize.* — S. HOROVITZ, M. E. SANGUINETI, E. GINI, A. H. MARCHIONI and L. B. MAZOTI have carried out numerous genetic investigations into the resistance of the "Amargo" corn to grasshoppers, various local types of floury endosperm, sterility, duplication of embryos ("siamensis") etc.

*Wheat.* — Special studies of the inheritance of disease resistance (*Puccinia triticina, P. graminis tritici* and *Ustilago tritici*) have been made, and more resistant strains, derived from various hybridizations, are now being tested by the Department of Agriculture. *Triticum durum* has been submitted to colchicine treatment, and sterile tetraploids were obtained.

Besides maize and wheat, genetical and cytological investigations are also conducted with *Salvia, Petunia, Cucurbita*, and other plants.

(b) *Facultad de Agronomía y Veterinaria de la Universidad Nacional de Buenos Aires.* — In its "Instituto de Genética" investigations on breeding, genetics, and cytology of various crop plants are under way. Of particular importance is the corn breeding work of J. M. ANDRÉS and P. C. BASCIALLI, which was started in 1933 by S. HOROVITZ. Many mutant types having been analysed and numerous inbred lines isolated; several varieties have been inbred. Hybrids have been obtained by crossing local lines inter se and also with strains introduced from North America. Until 1939 the best hybrid combinations were single crosses between local and North American lines.

J. M. ANDRÉS has made a genetical analysis of endosperm color of various Argentine corn varieties by crossing them with several linkage testers.

In the same institution very interesting cytological work has been carried out by E. L. RATERA on wild and cultivated *Solanum* species and by F. SAURA on various genera of the *Gramineae*. Cultivated potato varieties (*S. tuberosum* and *S. andigenum*) from the Argentine, Peru, and Chile have 48 somatic chromosomes, with the exception of the "Mantequilla" variety (*S. tuberosum*) which has $2n = 24$. Fourteen wild *Solanaceae*, native to the Argentine, have either 12, 18, or 24 haploid chromosomes. A group of spiny *Solanum* species (Section *Leptostemonum*) has also been analysed by E. L. RATERA, who found either 12, 24, or 36 haploid chromosomes. Furthermore, 15 wild potato species, including *S. Millanii, S. Parodii* and *S. Horovitzii*, were investigated cytologically, all of them found to have $2n = 24$. As Argentina is one of the important centers of the origin of the potato, these cytological investigations are of special interest in building up the phylogenetical relationships in this important genus.

In the *Gramineae* the principal species cytologically examined have been of *Paspalum, Poa, Stipa, Andropogon*, and *Phalaris*. In the first, diploids ($n = 10$), tetraploids, hexaploids, and octoploids have been found. All *Poa* species have $2n = 28$, and of three *Phalaris* species, one has $2n = 12$ and the others $2n = 14$.

As already pointed out, several state governments (Provincias) also maintain experiment stations where breeding work is carried out. The following should be mentioned:

(a) *Provincia de Tucumán: Estación Experimental de Tucumán.* — This well-known agricultural institution was founded in 1907 and is maintained by the

state government in coöperation with the sugar-cane industry. It has done excellent work, solving many agronomic problems related to subtropical crop plants, mainly sugar-cane and *Citrus* plants. With respect to plant improvement, William E. Cross and his assistants have done outstanding work with sugar-cane breeding. Thousands of seedlings derived from selfings and crossings have been raised at Tucumán; the best ones are tested in regional trials and some of the new "Tuc" canes have been extensively cultivated not only in the Argentine, but also in other countries where this plant is grown. Enrique F. Schultz's work with various fruit plants, mainly *Citrus* and other crop plants, is also well known and has furnished many practical results. Acclimatization and variety testing are also conducted there on numerous other economic plants, such as cotton, rice, peanuts, tung, sesame, sunflowers, etc. G. L. Fawcett's botanical and pathological researches with various plants have also contributed to the success of many investigations at Tucumán.

(b) *Provincia de Santa Fé: Instituto Experimental de Investigación y Fomento Agrícola-Ganadero.* — In its Agronomy Department several breeding projects the purpose of which is to improve several cereals, oil and forage plants, and also fruits and vegetables have been carried out.

(c) *Provincia de Buenos Aires.* — The Government of this province established experiment stations at Barrow (F.C.S.), Bellocq (F.C.O.), and in the Paraná Delta. The first two are dedicated to the improvement of wheat, oats, barley, flax, and forage plants, and the last one — *Estación del Delta del Paraná*—to the breeding of forest species and temperate fruit plants.

*Private Seed Companies.* — Enrique Klein — Criadero Argentino de Plantas Agrícolas Plá (F.C.C.G. B.A.) Provincia de Buenos Aires.

This private seed company has done outstanding work in plant improvement in the Argentine. Many of the "Klein" varieties of wheat, maize, and other plants are extensively grown in this country and also in Uruguay.

Three other private enterprises which do plant improvement work might be mentioned: José Buck, Defferrari, F.C.S. (Buenos Aires); Leonardo Benvenuto, Santo Domingo—Monte Buey, F.C.C.A. (Córdoba) and René Massaux at Pirovano, F.C.S. (Buenos Aires).

There is also one railroad company in Argentina, the *Ferrocarril del Sud*, which owns two experiment stations, one in the Province of Buenos Aires and the other in the Rio Negro Valley, where some breeding work with cereals and several fruit plants is under way.

One realizes, therefore, that the Argentine republic already has numerous institutions where good scientific work in plant breeding, genetics, and cytology is being carried on.

**Bolivia:** — At the University "Simon Bolivar" at Cochabamba, under the direction of Martin Cárdenas, the well known South American botanist, some breeding work was started in 1941.

Selfing of two local commercial maize varieties, "Wilcaparu" and "Amarillo Paltawaltacu," was done to isolate pure lines for future hybrid seed production. Several North American varieties were also introduced, but failed to develop into normal plants because of the prevalent climatic conditions and their susceptibility to *Puccinia sorghi*. Hybridization between local field corn and sweet corn varieties was also begun recently, in an effort to breed better sweet corn types.

H. Gandarillas is at present carrying on taxonomic and cytological studies on Bolivian potatoes. A collection of about 120 varieties of *Solanum andigenum* and many other species was gathered and chromosome counts made. Hybridization is also practised to breed a new drought-resistant variety having the characteristics of both local types, "Papa runa" and "Imilla."

There is an open field for plant breeders and geneticists in Bolivia; many native plants—for instance quinine (*Cinchona*)—should be subjected to breeding work, as the raw material is available in abundance through the great diversity of natural stands. Numerous types of maize are grown by the natives in regions of differing altitudes and climatic conditions, a situation which offers a tremendous wealth of material to the geneticist.

**Brazil:** — Of all Latin American countries Brazil is the largest. It covers a territory of 8,5 million square kilometers, exceeding the area of the continental United States. Its agriculture shows an extraordinary diversity; tropical crop plants, such as rubber, cocoa, etc., are grown in the north; subtropical crops such as coffee, sugar cane, and citrus fruits in its central regions, and temperate plants such as wheat, grapes, etc., in the south. Some regions have an average annual rainfall of over 3 m. while others are extremely dry. The east-central and southern parts of the country are most progressive because the climate there is more favorable to white settlement. Highly developed agriculture is found only in the eastern states bordering the Atlantic Ocean and in Minas Gerais, the large central province. Research work in genetics and related fields is now being carried on in somewhat less than half the provinces of Brazil.

Agricultural institutions where plant breeding, genetics, and cytology are being carried on belong to either the federal or state governments. The "Instituto de Experimentação Agricola," under the direction of A. B. Fagundes, of the "Centro Nacional de Ensino e Pesquisas Agronômicas" (federal), has its headquarters at Rio de Janeiro and supervises numerous experiment stations scattered through various agricultural zones of the country, each dealing with one or several local crop plants. The State of São Paulo has the oldest and best institutions for agricultural research, where pioneer work has been conducted in various fields.

(1) *Federal District.* — At its Deodoro Experiment Station (federal) breeding work with pineapples (*Ananas* sp. and *Pseudoananas* sp.) has been carried out for several years (F. C. Camargo and others) in an effort to improve varieties for local consumption, breed new types better suited for canning, and to find strains for fiber production. In the hybridisation work, one spineless form of *Ananas sativus*, called "Rondon," has been used extensively. It has been cultivated by the Indians in the State of Mato Grosso. The first generation hybrids between this type and common cultivated varieties have shown a great diversity of characteristics. Many individual selections, combining the spineless character (dominant) with other favorable features, have been made and propagated vegetatively. The resulting clones will be tested in comparative regional trials. The spineless character has been shown to be dominant, even in intergeneric $F_1$ hybrids between *Ananas* and *Pseudoananas*.

(2) *State of Baía.* — The federal government maintains in this state the São Gonçalo Experiment Station, where preliminary work on cotton breeding is done. In the last four years the state government has also been much interested in promoting breeding work with other plants, such as cocoa (*Theobroma cacao*), maize (*Zea*), tobacco (*Nicotiana*), castor beans (*Ricinus*), etc. Many young agronomists have been sent to the United States on fellowships, for basic training in genetics and plant breeding, and have recently started their work at several agricultural experiment stations.

(3) *State of Minas Gerais.* — At the *Sete Lagôas Experiment Station* (federal) intensive cotton breeding work is carried out to improve local types. Many North American varieties and selections from other states, mainly São Paulo, from which several hundreds of progenies are studied each year, have been introduced.

The *Estação Experimental de Patos* (State) is interested mainly in wheat, local and introduced varieties being improved through the pedigree method of breeding. Special attention is devoted to ways of obtaining rust-resistant types, the "Kenya" variety having been

used rather successfully for this purpose (O. VIEIRA DE NOVAIS.

*Genetics Division of the Escola Superior de Agricultura of Viçosa.* — Geneticists: GLADSTONE DE A. DRUMMOND, and AMÉRICO GROSZMAN. — This is one of the three best agricultural colleges in the country. It was organized by the state government under the direction of Dr. P. H. ROLFS, noted American horticulturist and educator, formerly connected with the University of Florida at Gainesville. While director of this college, Dr. ROLFS and his followers succeeded in building up a small but well-trained staff of professors and research workers, either by contracting foreigners, mostly Americans, or by sending young and well-selected graduates to the United States for advanced studies.

The Genetics Division, although quite new, is doing excellent work which is already furnishing practical results to the farmers; it is conducting breeding work with the following crop plants:

*Maize.* — Variety trials are planted in various parts of the state in order to substitute for local inferior varieties better yielders and more uniform types. Several hybrids between open pollinated varieties have been made and also tested at various zones; one of them, the cross between the yellow flint "Catete" and the yellow dent corn "Amarelão" has given significantly higher yields than either parental type and is now produced on a commercial scale. Inbreeding of several varieties was also started a few years ago, and single and top crosses have been made to select lines with high combining ability.

The heredity of an apparent new mutation, "embryão virado" (abnormal embryo), has been recently investigated.

Besides field corn, breeding work is also done with sweet corn. As American sweet corn varieties do not develop well in tropical and subtropical climates, they were crossed with a South American flint corn; after 3 generations of back crosses and intensive selection work, a new variety, "Doce ESAV," which seems to be very promising, was isolated.

*Cotton.* — The improvement work with this plant was organised by Dr. J. B. GRIFFING, director of this college for several years. Many varieties of *Gossypium hirsutum* were introduced and the more promising ones tested by regional trials. One of these, the "Acala," introduced in 1937, outyielded all the others and is now being distributed to the farmers. Individual plant selections have been made from several of the best varieties, some of the resulting lines having now been selfed for six generations. Hybridisation was also started a few years ago; crosses were made of *G. hirsutum* with *G. barbadense* and *G. purpurascens* in an attempt to make selections which in the succeeding generations combine high yielding capacity with fineness of fiber.

Genetic investigations are also carried out to study the inheritance of resistance to wilt (*Verticillium*) in interspecific crosses of *G. hirsutum* × *G. barbadense*. A new leaf color is also being studied genetically.

*Rice.* — Thirty good varieties have been tested in regional trials in coöperation with the Agronomy Division of the college (S. S. BRANDÃO), to select the best ones to be later improved through line breeding.

*Manioc* (*Manihot esculenta* Crantz). — In coöperation with the Biology Division (O. DRUMMOND) an attempt to select types which are resistant to a bacterial disease which causes great damage to the crop is being made.

*Peas* (*Pisum*). — Genetical investigations are being carried out in order to determine the causes of the splitting of the teguments.

*Ornamentals.* — Pure-line breeding and hybridization work is being done with *Dahlia, Antirrhinum,* and *Dianthus.*

Besides the above-named institutions, the State Department of Agriculture at Belo Horizonte is also doing some preliminary breeding work with *Ricinus,* rice cotton, and several other crop plants.

(4) *State of Pará.* — This huge state, which comprises a little less than half the Amazon valley and its adjacent areas, lies right at the equator. Its climate is tropical throughout. Agriculture is still most primitive here, although its great natural plant resources, especially *Hevea,* have been explored by man for many years. At present the government is seriously trying to promote the establishment of modern agricultural methods and to begin the cultivation of some of its most valuable native plants.

*Instituto Agronômico do Norte.* — This institution started to operate about two years ago and is devoted especially to research in rubber (*Hevea* spp.) and other plants native to the Amazon valley. F. C. CAMARGO is director; his main collaborator is LUIZ O. T. MENDES. Both were formerly of the Instituto Agronômico of the State of São Paulo.

*Rubber* (*Hevea* spp.). — The story of rubber is well known to most of the readers of this book. Brazil was formerly the only country which produced *Hevea* rubber. It was extracted from plants growing wild in the Amazonian forests, because no plantations existed. Later, over in the Orient, rubber trees were raised from seed. Cheap labor, the absence of important diseases of the rubber plant, and the cultivation of highly selected clones made it possible to produce there huge quantities of cheap rubber of good quality. Consequently, Brazil, with only its native trees could not meet the competition. At present the Orient is in the hands of the enemy. As the war industries require enormous quantities of this important raw rubber, Brazil is asked again to furnish as much of it as possible.

In order that Brazil may be able to compete in future peace times with cheap oriental rubber and synthetic rubber, it is necessary that plantations of only highly selected trees be developed. The breeding work which was started at the Instituto Agronômico do Norte in coöperation with the Ford Rubber Plantations and the U. S. Department of Agriculture is, therefore, of great importance to the future of the Brazilian rubber industry. To get high yielding clones resistant to the leaf disease (*Melanopsammopsis ulei* = *Dothidella ulei*) is the main object of this work.

Many specimens of species (*Hevea brasiliensis, H. spruceana, H. benthamiana,* and *H. guianensis*), varieties, clones, and progenies have been collected at the experimental grounds of the Instituto with the coöperation of Dr. JOHN BALDWIN, Jr. of the U. S. Department of Agriculture. Some of these types are simultaneously being studied at two sub-stations at Rio Branco (Acre) and Porto Velho (Madeira River). Many importations have been made from abroad (Orient and Central America) through the courtesy of the U. S Department of Agriculture; the best selections of the Ford Plantations at Belterra and Fordlandia have been included in this collection. All this material is under observation primarily to determine its resistance to the leaf diseases; the best plants are propagated asexually and will be tested in regional trials for latex production. A large number of individual selections have also been made from native trees in small old plantations. Their progenies and clones have been taken to special nurseries where they are now being tested for disease resistance. Besides this line breeding, extensive hybridization work is to be conducted, but so far this is being done at only the Ford Plantations, as the plants of the Instituto Agronômico are not operating yet. Crosses are made by FLAVIO BELTRAME and L. A. BERRY, Jr., agent of the U. S. Department of Agriculture, between clones of the same species, mainly between high yielding oriental and local disease-resistant selections, and also between different species, like *H. spruceana, H. benthamiana,* and *H. guianensis* which are particularly resistant to the leaf disease, but produce less latex than *H. brasiliensis.* Several back-crosses are also being made with hybrids previously obtained by the Ford Plantations.

Recently also preliminary work on chromosome duplication by colchicine was started. The main problem is to determine its effect on general plant development and especially on latex production.

In a few years, the best yielders and the most disease-resistant types will be propagated as fast as possible and furnished to private planters.

*Timbó* (*Lonchocarpus utilis* and *L. urucú*). — Because rotenone is an important insecticidal material, improvement work was also recently started with this group of plants. Individual selections based on total

root weight and rotenone content (which varied from less than 1% up to 20%!) were made; the most promising ones are being propagated for cultivation.

(5) *State of Paraíba.* — In this small northeastern state cotton breeding work is being conducted by federal research workers at the Alagoinha Experiment Station. In 1939 many individual selections were made from several local and imported cottons, and since 1941 special attention has been devoted to selecting those having most resistance to the cotton wilt caused by *Fusarium vasinfectum*. CARLOS FARIA, who works with the perennial Mocó cotton (*G. purpurascens*), is particularly interested in the breeding of long staple types and is said to have specimens with a fibre length of 60 mm.

The State Department of Agriculture is also doing some selection work with other crop plants, such as *Ricinus*, rice, and others.

(6) *State of Pernambuco.* — Pernambuco is perhaps the most progressive of the northern and northeastern States. Both Federal and State Departments are working actively to improve agriculture, and every year the Escola Superior de Agronomia is graduating several enthusiastic young agronomists. The State Department of Agriculture is conducting experiments in the breeding of various crop plants. In this Department HEITOR AIRLY TAVARES, one of the most efficient agronomists of northeastern Brazil, has been responsible for all the work. He has been assisted by seven other agronomists.

*Cotton* (*Gossypium hirsutum* L. and *G. purpurascens* Poir.). — At Pernambuco the Ministerio da Agricultura maintains the Surubim Experiment Station where cotton breeding work was started in 1938. Individual selections, progenies, and new strains have been isolated from three *G. hirsutum* varieties, H-105, Pitaguarí, and Texas; and hybridization between the H-105 variety and the Serigi cotton (*G. hirsutum*) has been started. In $F_1$ several new characters appeared, such as deeply furrowed leaves and spotted petals; many specimens from the succeeding generations are to be tested for yielding capacity and fiber quality (V. VELOSO).

In the State Department of Agriculture improvement work with both *G. hirsutum* L. and *G. purpurascens* Poir., the famous perennial long-staple cotton, indigenous to northeastern Brazil is going on. After the introduction of *hirsutum* varieties many years ago, natural hybridization tended to spoil the excellent fiber qualities of the *purpurascens* types, for both have the same number of chromosomes ($2n = 52$) and intercross freely. Many *hirsutum* varieties have been introduced from the United States and other Brazilian states; for many years efforts have been made to select types especially adapted to several ecological regions of Pernambuco; they must be good yielders, produce fibers of good quality at least 30 mm. long, and have a ginning percentage of not less than 33%. The varieties of the Bourbon group (*G. purpurascens*) have been improved mainly in their staple qualities, a minimum length of 40 mm. being required. The best specimens of this type of perennial cotton have been successfully propagated by grafting, a method which is said to be economical even for commercial planting. It is hoped that this breeding work will succeed in repurifying this excellent Brazilian cotton, which has superb market possibilities.

*Castor bean* (*Ricinus* sp.). — With the increasing market requirements of castor oil, it has been urged that selected seeds of this plant be furnished the farmers. Many varieties have been collected in the state, where the plant grows subspontaneously mainly at the S. Francisco River banks; and others have been introduced from southern states. Individual selections of the most promising ones have been made in order to isolate improved lines.

*Manioc* (*Manihot esculenta* Crantz). — This is a typical Brazilian root plant indigenous to certain regions of the northeast, including north Baía and Pernambuco. The improvement work was started by bringing together a collection of over 400 types, which were first subjected to a thorough taxonomical study; about 200 different types were retained. These were then analysed for their starch content and percentage of cyanhydric acid. Those with over 30% starch—some had close to 40%—were selected for comparative regional tests. The best ones have been propagated and cuttings have been furnished to the farmers. As these varieties are clones, no improvement can be obtained through individual selections. Therefore various crosses have lately been made in an attempt to combine in a new variety the favorable characters of two or more types.

*Maize.* — So far mass selection has been practised in only two varieties, "Catete" and "Gorotirê," the last one having been introduced from the State of Amazonas. Variety crosses are planned, and $F_1$ seed is to be furnished the farmers, should these hybrids be superior to local mass selected varieties.

*Sugar-cane* (*Saccharum*). — Besides some work done at the Federal Experiment Station of Curado, the State Department of Agriculture does extensive variety testing and has under observation numerous clones derived from seedlings obtained through hybridization by Mr. APOLONIO SALLES, now Minister of Agriculture at Rio de Janeiro. New crosses are planned in an attempt to breed newer and still better varieties.

*Caroá* (*Neoglaziovia variegata*). — This is an important native fiber plant of northeastern Brazil, which is now being cultivated. Improvement work has started to isolate lines with higher fiber percentage and longer and more resistant fibers.

(7) *State of Rio de Janeiro.* — In this small eastern state only two federal institutions are doing some work on plant breeding.

*Estação Experimental de Campos.* — Exclusively dedicated to sugar-cane work, this station has been trying to develop new and superior varieties. A large number of seedlings, obtained either through selfing of several imported varieties or through artificial hybridization are raised every year. Several P.O.J. canes, as well as Coimbatore and Tucumán selections, have been used for this work. Two new varieties, nos 33-4 and 33-8, are now being tested on large plots at several sugarcane plantations of the state.

*Instituto de Experimentação Agrícola.* — This federal institution, which supervises all experimental work done by the Ministério da Agricultura in the whole country, has its headquarters at Km 47 of the highway which connects the cities of Rio de Janeiro and São Paulo. At its experimental grounds the following breeding work is conducted:

*Castor bean* (*Ricinus communis*). — GRIJALVA FERNANDES is now in charge of these investigations, after having worked for several months at the Genetics Division of the Instituto Agronômico, Campinas, S. Paulo. The breeding work is done exclusively with a dwarf type of castor bean, introduced from São Paulo, which has a good yield, is easily picked, and bears its fruits indehiscent in the field. Correlation studies of various characters were made; for instance it was found that earliness, as measured by the number of days from germination to the opening of the flowers on the first and main inflorescence, is negatively correlated with the number of nodes on the main stem and positively correlated with the length of the internodes. Special selections were made for earliness; these selected strains are said to flower 15 to 20 days earlier than the common varieties. Improvement has also been made in general yielding capacity, oil content of the seed, and disease resistance (*Botrytis, Fusarium,* etc.).

Besides breeding work, the heredity of various characteristics, such as dwarf growth habit, shape of leaf, fruit surface, dehiscence, and of several quantitative aspects, such as size of inflorescence, earliness, resistance to diseases, etc., are being investigated.

*Guandú* (*Cajanus indicus*). — This leguminous plant thrives well in the lowlands of the State of Rio de Janeiro (Baixada Fluminense). Common varieties are, however, very heterogeneous. Improvement work has recently been started by OSWALDO MENEZES to isolate high yielding and early lines with soft pods which can be consumed as a vegetable.

(8) *State of Rio Grande do Norte.* — The Federal Cruzeta Experiment Station, located at Seridó, has been working with the cotton varieties of the Bourbon group (*G. purpurascens*) since 1930, particularly with the famous *Mocó* long-staple variety. Line breeding

and hybridization have been practised and the best types kept by grafting.

(9) *State of Rio Grande do Sul.* — This southernmost State of Brazil has a temperate climate and therefore with a different agriculture from central and northern Brazil. Wheat, flax, and temperate fruits—grapes, apples, etc.—are the principal crop plants under cultivation. Breeding work is being carried on by federal and state institutions and concerns the following plants:

*Wheat.* — Dr. IWAR BECKMAN, from Svalöv, Sweden, is one of the pioneer plant breeders in Brazil; he started his work in 1925 at the State Experiment Station of ALFREDO CHAVES, where he found several strains selected previously by CARLOS GAYER. After the importation of many varieties from abroad, he began to work on a large scale improvement project, annually making thousands of selections, testing progenies and lines, and doing numerous hybridizations. In 1929 his laboratory was transferred to the Estação Experimental Fitotécnica de Bagé, where he is still working. In the years 1932-34, seeds of his first selections were sold to the farmers and grown with great success; they were particularly resistant to *Puccinia glumarum* which was first noted in South America in 1929, and caused considerable damage in the wheat fields of Rio Grande do Sul, Uruguay, and the Argentine. His last selections—"Fronteira," "Surpreza," "Frontana," "Rio Negro," and "Certeira"—are outyielding the best varieties formerly under cultivation, even in Uruguay, and show definite advantage with respect to the following characters: *1,* better adapted to a long period of sowing; *2,* greater resistance to rusts (*Puccinia* spp.,); *3,* superior grain weight; *4,* better type of grain; and *5,* superior baking qualities.

At another State Experiment Station (Julio de Castilhos), B. OLIVEIRA PAIVA is also working on wheat breeding. He has produced several lines well adapted to the locality. Lately he has also been crossing wheat and rye.

Primarily because the above-outlined breeding work resulted in the production of new and improved varieties, the State of Rio Grande do Sul again last year exported wheat to other Brazilian States; it had not done so for the past century.

*Oats and barley.* — The breeding of oats and barley was also started by Dr. IWAR BECKMAN and is now being continued by OSCAR VANZON; good yields and resistance to *Puccinia coronifera* were the main objects in oat improvement; "Bagé" and "D. Pedrito" are the two new outstanding varieties bred at the Fronteira Station. Improved barley varieties for forage and also for the beer industry are now being distributed to the farmers.

*Rice.* — At the Gravataí Experiment Station, under the supervision of D. C. BERNARDES, a new project in rice breeding has recently been started, line selection and hybridization are being practised on a large scale.

*Potatoes.* — To purify locally grown varieties by clonal selection and also to breed new types through selfing and hybridization, last year F. GUIMARÃES began work at one of the Horticultural Experiment Stations located at Rio Grande County. The main object is to establish a permanent source of seed potatoes to be sold to the farmers.

*Maize.* — Local varieties grown at Rio Grande have been improved by government agronomists and by private farmers using mass selection. In 1940, however, a new project of corn breeding was started at the Estação Experimental Fitotécnica da Fronteira at Bagé by JOSÉ A. SOUZA SOARES. Inbreeding is practiced with both local and imported varieties, especially those from the Argentine and U. S. A., to isolate pure lines that are to be used in hybrid seed production.

*Flax.* — Flax is grown extensively in Rio Grande do Sul; at the Farroupilha region it is fiber flax, and further south, oil flax. Prof. JOSÉ GROSSMAN, geneticist of the Escola de Agronomia e Veterinaria of the University of Porto Alegre, has been engaged in fiber flax breeding since 1932. His new varieties, "Farroupilha," "Viamão" and "Caxias," obtained either through line breeding or hybridization, are superior to former local and imported varieties. At Bagé, JOSÉ S. SOARES has also been engaged, since 1939, in the improvement not only of fiber flax, but also of oil flax; resistance to diseases, total oil production per area, and adaptability to late planting are the most important factors in selection.

*Fruits and Vegetables.* — Mainly at the Pelotas Experiment Station, of the Ministerio da Agricultura, under the direction of EDGAR FERNANDES TEIXEIRA, valuable preliminary work has been conducted with a large number of temperate fruit plants and vegetables. Many varieties such as apples, pears, plums, peaches, strawberries, cherries, quinces, almonds, etc., have been imported from other States and from abroad. Their behaviour is studied in detail, and some of them will be used in future breeding work. Among the vegetables, special attention is devoted to onions, peas, beans, and the *Brassica* species. The main object of the work is to select first grade types which produce seeds abundantly in this state. Several of these new varieties have adapted themselves very well to the climate of south Brazil and are already being propagated for distribution to the farmers.

This experiment station has also organised a well equipped cytological laboratory, where research will be started soon.

*Onions.* — The State of Rio Grande is the most important center of onion production in Brazil. Its onions are shipped to several other states. Extensive breeding work is done at the Domingos Petrolini Horticultural Experiment Station by F. GUIMARÃES on many local and imported varieties. Thousands of plants have been selfed and their progenies studied to isolate improved types that yield better onions of desirable shape and color and have greater resistance to diseases and to shipping injuries.

In addition, some breeding work is also being done at various experiment stations with *Manioc* (*Manihot esculenta* Crantz) field beans, and several forage plants.

(10) *State of São Paulo.* — This State has the oldest and the best agricultural institutions of the country and holds the leadership in the modernization of agricultural methods. Its climate is tropical at the sea coast, temperate at altitudes between 1,000 and 1,500 ms, and subtropical at the central plateaus, the altitude of which varies mostly between 400 and 700 ms. It is the world's largest coffee producing region, over two billion trees having been planted on an area of about two million hectares. Second in importance is the cotton industry; the state's total production which amounted to less than five million kg. (lint) in 1930, exceeded 380 million kg. in 1941. All seeds (more than 800,000 bags of 30 kg. in 1943) were grown and sold to the farmers by the State Department of Agriculture. Other important crop plants are maize, rice, field beans, castor beans, *Citrus* fruits, bananas, and many others according to the region.

Research on plant breeding, genetics, and cytology is, for the most part, carried out at two important institutions, the *Instituto Agronômico do Estado de São Paulo* at Campinas and the *Escola Superior de Agricultura "Luis de Queiros"* at Piracicaba.

(a) *Genetics Division of the Instituto Agronômico.* — This Division was established in 1927, but work started only in 1929 under the direction of E. TASCHDJIAN, an Austrian geneticist who stayed for two years. A new research program was organised by the author of this article in 1932. The Division now comprises three subdivisions: plant introduction, cytology, and genetics, in which research is carried out with the following economic crop plants:

*Coffee.* — To begin with, a large collection of varieties of *Coffea arabica* L., grown in the state, and also of many other imported species was established at Campinas and subjected to a thorough taxonomical study (C. A. KRUG, J. E. T. MENDES and ALCIDES CARVALHO). In all 27 varieties of *C. arabica*, including 7 new ones, were identified. At the same time a detailed cytological analysis was made of all representatives of the genus (C. A. KRUG and now continued by A. J. T. MENDES). The basic chromosome number was found to be *11,* most of the varieties of *C. arabica,* the important economic species being tetraploids, having $2n = 44$; in this species also one dihaploid with $2n = 22$ and two polyploids with respectively $2n = 66$ and $2n = 88$ were found. Through interspecific hybridization various triploids were synthesized and

through colchicine treatment (A. J. T. MENDES) various polyploids, including one amphidiploid (hexaploid), were obtained. Other polyploids occurred among intervarietal crosses. Detailed studies on chromosome morphology in several species and meiosis in diploids, polyploids, and aneuploids have been made. It is apparent that the *arabica* species (2n = 44) is an alopolyploid, the *C. canephora* species possibly being one of its ancestors.

The heredity of about twenty characteristics in *C. arabica* is being investigated; the results of several of these analyses have been completed and already published (C. A. KRUG and ALC. CARVALHO).

Among fourteen characteristics analysed, six are recessive to the normal type, five of incomplete dominance, and three completely dominant. One of the recessive genes, *nana*, revealed great instability in certain plants, mutating frequently from dominant to recessive and vice versa. Hypotheses regarding the evolution of several economic varieties have been postulated through mutations, starting with the *mokka* variety, still growing wild in Abyssinia. Several somatic mutations (chromosomal and genetic) have been observed and described in *C. arabica*, and the existence of the true endosperm has been proven by genetical methods (C. A. KRUG) and by a detailed cytological investigation (A. J. T. MENDES). The genetics of interspecific hybrids has also been studied in detail, several genes having been transferred from one species to another; it is surprising that several dominant *arabica* genes continue to show dominance in various interspecific $F_1$'s. Recently investigations were started to determine the causes of self-sterility in several species of *Coffea* and the effect of artificial chromosome duplication on this characteristic (C. H. T. MENDES).

Besides these cytological and genetical investigations, an extensive breeding project was started in 1932 in coöperation with the Coffee Division (J. E. T. MENDES) to improve local varieties and to breed new ones by hybridization (C. A. KRUG and ALC. CARVALHO). To begin with, over 1,000 individual selections were made from among the most important commercial varieties on private farms and special breeding plots. Their progenies have been studied at three important coffee regions in the state, which differ in soil and climate. In the best of them new selections have been made and propagated separately. Besides the isolation of superior lines by selection, several hundred hybrids were made, in the $F_2$'s of which new and important types have been selected. In this project a total of approximately 37,000 coffee plants which are harvested separately every year are under individual observation. The main factors of selection in this breeding work are as follows: total yield; regularity of production (avoidance of great variations from year to year); resistance to "die-back," a physiological disturbance caused by overproduction; adaptability to regional conditions; easiness of picking; and good sized seeds producing a good quality coffee. One of the new varieties of *C. arabica*, called *semperflorens*, which originated through mutation of the *bourbon* variety, is characterized by an almost continuous flowering; this type of coffee is expected to be of interest to future small coffee plantings and is now being tested at various regions of the State.

In spite of the fact that eleven years are hardly enough to give a good start to such a project—a coffee plant does not begin to produce until three years after germination, and the yielding capacity of a tree must be studied for at least six consecutive years—the Instituto Agronômico has so far this year distributed nearly 1,500 kg of selected seeds to the farmers in various coffee growing regions.

*Maize: Field corn.* — Mass selection of maize was started by PAULO CUBA of the Agronomy Division in 1928; several of the standard varieties were considerably improved by this method. In 1932, however, a large new breeding project was organised (C. A. KRUG). Over 3,000 plants of these standard varieties (yellow and white flint, and white dent corns) were self-pollinated that year; inbreeding and selection based on morphological characteristics and combining ability revealed by top-crosses have been continued since then with the assistance of G. P. VIÉGAS, now the head of the Cereal Division, and L. PAOLIERI. Several inbred lines of superior qualities have been isolated by these methods and a few hundred single, double, and three-way crosses have been tested at several regional experiment stations, some of them for three consecutive years. Among many others, three different single crosses (yellow flint) have outyielded the best open pollinated varieties in comparative trials by 15 to 35%. They are now produced on large crossing plots. The hybrid seeds will be distributed to a group of selected farmers next year. Many inbreed lines have also been imported from the United States (Iowa, Illinois, Florida, North Carolina, etc.); it is hoped that some of them may be useful for combining with local lines, mainly to produce superior yellow dent hybrids. In the near future it is hoped that part of the area now devoted to common open pollinated varieties will be sown to superior hybrid corn. To build up new and always superior pure lines, new varieties and types are annually introduced (the maize collection includes now about 850 different types), compared in regional trials, and the best of them used for inbreeding.

*Sweet corn.* — American sweet corn varieties were introduced in 1932 (C. A. KRUG), but not one of them yielded well, for they were susceptible to diseases and insect injury. Mr. G. P. VIÉGAS crossed one of these varieties with an inbred line of yellow flint corn, after several years of selection and back-crossing (L. PAOLIERI) a new variety of sweet corn *"Milho Doce Paulista I.A. no 1,"* which resembles field corn in plant habit and produces very excellent, large ears of yellow sweet corn was developed. This new variety is now being multiplied for distribution to growers. Recently, inbreeding has also been tried on this variety and on other sweet corns for future hybrid seed production.

*Pop corn.* — Local varieties of pop corn have rather small seeds and a low yielding capacity. New varieties which apparently do well under local climatic conditions were imported from Lafayette, Indiana (U.S.A.) in 1941; they are superior in quality and yielding capacity. Inbreeding of several varieties was also started last year (L. PAOLIERI) to isolate pure lines, later to be used in hybrid seed production.

*Broom corn (Sorghum).* — In spite of the fact that the broom corn grows well in São Paulo, large quantities of panicles are annually shipped from Argentina for broom manufacture. Since 1933 one of the local varieties has been considerably improved through selfing and continuous selections (C. A. KRUG and G. P. VIÉGAS); several of its main defects have been eliminated. One of the new lines, no 37-3, has been cultivated on a large scale and seeds distributed to the farmers. Several varieties have been also introduced from abroad and some of them, mainly several dwarf types, are used in the breeding program (L. PAOLIERI).

*Field beans (Phaseolus vulgaris).* — Since 1930 work has been done with field beans in an attempt to replace local heterogeneous varieties with superior pure lines (C. A. KRUG, J. B. DE CASTRO and L. A. NUCCI). Many varieties were collected, the best ones compared in regional variety trials, and several thousand individual selections made from the most promising ones. Progenies and strains were tested at various experiment stations of the Instituto Agronômico, and the two best ones multiplied for distribution. Besides this single line breeding, two other projects were started in 1937 (L. A. NUCCI) to breed new types by hybridization resistant to mosaic and to rust (*Uromyces appendiculatus*). Several white seeded mosaic-resistant varieties were introduced from Idaho (U.S.A.) and crossed with some of our best local selections; in $F_2$'s and succeeding generations many selections were made and tested for resistance to this virus disease. Some of the new lines are very promising and are expected to replace the old ones. To obtain rust resistance, the highest yielding, but susceptible, lines were crossed with black bean selections which have proven to be highly resistant. The new lines were then compared with the old selections in several regional trials.

A new breeding project was also started this year to obtain higher resistance to anthracnose.

*Rice (Oryza sativa).* — Irrigated and upland rice are extensively grown in the State of São Paulo, as

this cereal constitutes one of the most important foods of its population. To improve local varieties and breed new ones by hybridization, work was started in 1935 (G. P. VIÉGAS and E. G. GERMEK in two regions, one located at the Paraiba Valley, the largest irrigated rice producing area in the State, and the other in the interior where upland rice is grown extensively. Our variety collection now comprises a total of 370 types which were introduced from other States of Brazil and from abroad, mainly from India and the U.S.A.; some of these importations compare favourably with local types. The best lines derived from large numbers of individual selections and also from several crosses are now being compared at regional trials, some of them are very promising.

*Cotton* (*Gossypium hirsutum*). — Cotton selection work was started at the Agronomy Division of the Instituto Agronômico by R. CRUZ MARTINS in 1924. Varieties, both local and foreign North American, were first compared in regional trials. Since 1925 individual selections have been made from the "Texas" and "Express" varieties. Later, a large number of selections was made every year and numerous progenies, new and old strains compared in regional trials. The main object of this work is to obtain high-yielding strains, which produce cotton of an average staple length of 28-30 mm. with high lint percentage and are well adapted to most of the cotton growing regions. Since 1929, when the São Paulo cotton industry started to develop, these selections have been grown extensively, because the State controls the entire cotton seed distribution (over 800,000 bags of 30 kg. were sold to the farmers in 1943). The exclusive cultivation of these strains is the main reason why São Paulo cotton has been well accepted at various foreign markets (Canada, Japan, Europe).

In 1936 Dr. S. C. HARLAND, noted British cotton geneticist, was contracted by the São Paulo Government to take charge of the cotton breeding work at the Genetics Division of the Instituto Agronômico. He introduced his valuable collection of *Gossypium* species, varieties from Trinidad, and many other commercial varieties from the U.S.A., South Africa, and other cotton growing countries. Thousands of individual selections and numerous crosses were made with several of these new cottons; special attention was devoted to a small sized South African type called "Gatooma." Dr. HARLAND'S work was continued in the Genetics Division by his former assistants (G. FRAGA, JR.; ISMAR RAMOS and M. V. MORAES). Some of the new lines derived from the "Stoneville" and "Delfos" varieties have been shown to be superior, in several respects, to the strains of "Texas" and "Express," and have already been planted in multiplication plots to be later distributed to the farmers. A few new long-staple Delfos lines which have an exceedingly good quality staple of 38 to 39 mm. and which compare favourably with the "Seridó" cotton (*G. purpurascens*) imported from northeast Brazil have also been isolated from some of Dr. HARLAND'S selections.

Some cytological work has also been carried out by A. J. T. MENDES, the head of our Cytology Division. The somatic chromosomes were doubled by colchicine in *G. hirsutum* and also *G. herbaceum*, and the effect of this duplication on chromosome behaviour at meiosis was studied.

Breeding for disease resistance has also been the object of various investigations; cotton strains resistant to angular leaf spot (*Bacterium solanacearum*) and to the "Ramulose" disease (*Colletotrichum gossypii* South.), have been developed by Dr. HARLAND'S former assistants and mainly by A. S. COSTA, the plant pathologist of the Genetics Division.

*Tung* (*Aleurites fordii*). — As the Tung industry apparently has a promising future in this State, the Genetics Division started selection in 1936 (C. A. KRUG and P. T. MENDES). Seed imported from the U.S.A. and China gave plants, that were heterogeneous in growth habit, yielding capacity, and fruit and seed characteristics. Over a thousand individual selections were made on private plantations, and the quantity and quality of their yields (oil %, etc.) registered for a period of several years. From the best ones progenies and clones are now under observation at various regional trials, and seeds and bud wood of the most promising ones have already been distributed to private growers. Observations on flower biology and crosses between selections of *A. fordii* and *A. montana* have been made in an attempt to breed still better types.

*Castor beans* (*Ricinus communis*). — This plant, introduced from Africa at the beginning of the European colonization of Brazil, grows subspontaneously in nearly every state of this country. Its extensive cultivation, however, is more recent and one which has been stimulated by present war requirements, especially in São Paulo. Breeding work was also started in 1936 in the Genetics Division (C. A. KRUG and P. T. MENDES). Many varieties were collected in this and other states. A new dwarf type of excellent qualities was immediately propagated and is now extensively grown by the farmers. This dwarf type, probably originated by mutation, is a high yielder giving two crops in two consecutive years on good soils. It can be grown closely spaced, and is picked easily because of the reduced size of the plant. The seeds are of average size and have a high oil content. Breeding work (line breeding and hybridization) is at present mainly concerned with further improvement of these dwarf varieties, especially with increasing their yielding capacity and their resistance to various diseases (*Botrytis, Fusarium*, etc.). Seeds of the dwarf type have been sent to various other states and to other countries, including the United States and Venezuela.

*Quinine* (*Cinchona*). — In 1938 a new attempt was made to cultivate this important medicinal plant in São Paulo, in spite of the fact that this State does not offer an ideal climate for this plant. Many importations were made, mainly through the Division of Plant Exploration and Introduction of the U. S. Department of Agriculture (courtesy B. Y. MORRISON) and A. CARVALHO, the head of our Plant Introduction Division, who spent several months in the Andes collecting seeds of various *Cinchona* species. Though only recently a beginning was made to acclimatize this plant, some selection work has already been started at the Genetics Division (C. A. KRUG, A. CARVALHO and C. N. ANTUNES). All plants which are reacting most favourably to the new environment have been propagated, and their progenies are now being studied at the Cinchona Experiment Station and at various regional experimental plots. Hybridization between the most promising plants has also been started. Chromosomes were counted in several species (A. J. T. MENDES), $2n = 34$ being found in all of them; investigations on the artificial doubling of the chromosomes by colchicine has been started recently, mainly to study its effect on the alcaloid content of the bark.

*Potatoes* (*Solanum tuberosum*). — Potato work was started in 1929 (C. A. KRUG) and has been continued by J. B. DE CASTRO and L. A. NUCCI. Old locally grown varieties imported from the Argentine, which were extremely susceptible to virus and other diseases and of inferior eating quality, were gradually replaced by superior European varieties, imported mostly from Holland. Certified seed has been produced at regions of high altitudes (Instituto Biologico). But even the best imported varieties "degenerate" soon, and it is therefore necessary to breed new varieties still better adapted to local conditions. Preliminary work in seedling raising has been done in the Genetics Division of the Instituto Agronômico. Plans have been made to amplify these investigations as soon as a more favourable locality is available (A. S. COSTA).

*Sugar-cane* (*Saccharum*). — At the Piracicaba Experiment Station sugar-cane breeding was started by J. M. DE AGUIRRE, JR. in 1934. As this plant usually does not flower at this station, most of the selfings and crosses were carried out at a small experiment station located near Santos at sea level. For this work the Kassoer and several P.O.J., Tucumán, and Coimbatore selections were used and thousands of seedlings raised. After making rigid selections based on total yield, sugar content and mosaic resistance, a certain number of clones have been isolated. These are now being compared in regional trials with the best cultivated varieties.

*Tobacco* (*Nicotiana*). — Under the direction of Prof. F. G. BRIEGER, of the Escola Superior de Agricultura

of Piracicaba and in close coöperation with the Tobacco Division of the Instituto Agronômico (A. RODRIGUES LIMA), an extensive programme of tobacco research is being carried out (R. FORSTER). The heredity of various characters is being investigated, and better varieties more resistant to virus diseases are being raised (mosaic and "vira-cabeça;" A. S. COSTA collaborator). Chromosome duplication with colchicine was also obtained (A. J. T. MENDES).

*Citrus plants.* — A coöperative research program to investigate several aspects of *Citrus* genetics, cytology, embryology, and breeding was organised a few years ago. (Genetics and Horticultural Divisions of the Instituto Agronômico; C. A. KRUG, A. J. T. MENDES, S. MOREIRA, O. BACCHI; Limeira Experiment Station: A. RODRIGUES FILHO; Escola Superior de Agricultura of Piracicaba: Prof. F. G. BRIEGER, J. T. A. GURGEL). Most of this work is carried out at the Limeira Experiment Station where the main collection of *Citrus* plants is grown. So far several papers on chromosome numbers, triploid varieties, effects of rootstocks, improvement of the "Baia" orange, pollen fertility and its relation to seediness, and how it is influenced by the rootstock, and several other subjects have been published.

The Genetics Division and other branches of the Instituto Agronômico are making investigations into the breeding of the following plants: wheat, rye, sweet potatoes, soy beans, manioc, sunflowers, sisal, pineapples, and others. This work is not so extensive as that for the larger crops just described.

(b) *Escola Superior de Agricultura "Luiz de Queiroz" of Piracicaba: — Cadeira de Agricultura Especial.* — For many years Prof. CARLOS T. MENDES has been improving maize, manioc, and rice.

*Cadeira de Genética e Citologia.* — Under the supervision of Prof. F. G. BRIEGER this Division for research and teaching in genetics and cytology was organised in 1935. The following investigations have been conducted there:

*Maize.* — An attempt is being made by crossing local types with very early European and Canadian types, to breed an early, well adapted field corn which flowers in 45 to 55 days. The economic value of four new sweet corn varieties which were obtained by hybridizing a North American early sweet corn hybrid with local field corn is now being investigated. Among others, the following investigations with maize are carried out by Prof. BRIEGER and his assistants (E. A. GRANER and G. O. ADISON): genetical studies of quantitative characteristics and their statistical analysis; the effect of modifiers on aleurone color of indigenous corn; hybridizations between indigenous corn and *Euchlena mexicana* from Mexico and Guatemala, and *Tripsacum australe* from the State of Mato Grosso; histology of the flower of maize from Baia and Paraguay, and of *Euchlena* and *Tripsacum;* genetical analysis of the local *tunicata* type; investigations on yellow endosperm and aleurone colours; synthesis of linkage testers specially adapted to local climate, etc.

*Manioc* (*Manihot esculenta* Crantz). — Work of special interest has been conducted by E. A. GRANER with this typical Brazilian plant; the heredity of various characteristics has been investigated and extensive cytological analyses, including chromosome duplication by colchicine and its effect on plant characters and root production, carried out.

*Castor bean* (*Ricinus communis*). — J. T. A. GURGEL has been interested in genetical and breeding investigations with this oil plant, several qualitative and quantitative characteristics having been analysed and new strains of the dwarf variety having been developed with a special type of condensed branching.

Several other investigations are being carried out by Prof. BRIEGER and his collaborators on the following plants: papaw (*Carica papaya*), several vegetables, *Antirrhinum, Lathyrus,* and Mango (*Mangifera indica*). Besides that, E. A. GRANER has done special research on chromosome structure in somatic mitosis of various plants and is now investigating the presence of knobs on chromosomes of Brazilian maize types, and Prof. BRIEGER is doing considerable work on statistics and field plot technique.

(c) *Forestry Department of the Cia. Paulista Railroad, Rio Claro.* — The Companhia Paulista de Estradas de Ferro, the most important private railroad company in the State of São Paulo, recently organised, under the direction of the author of this article (assisted by A. SILVEIRA ALVES), an extensive *Eucalyptus* breeding project at its main forest station at Rio Claro. The late Dr. EDMUNDO NAVARRO DE ANDRADE, the former director of this Forestry Department, after 1940 introduced over one hundred species of this important Australian genus, did extensive experimental work with them, organised seventeen forest stations for the Company and had planted over twenty million trees of some of the best adapted species. For this work he was awarded the "Meyer Medal" at Washington, D. C. in 1940. The Forestry Division is in great need of selected seed now, as their *Eucalyptus* plantations will be extended to a total of about sixty million trees. The new laboratory, which was organized a year ago, is doing work on the following lines:

1) *Taxonomic research:* investigations on inter- and intraspecific variability; organisation of a large herbarium; attempts to establish a new classification of the species according to their cytogenetic relationships.
2) *Cytological research:* determination of chromosome numbers and morphology; meiosis; pollen; cytology of interspecific hybrids; chromosome duplication with colchicine.
3) *Genetical research:* studies of the heredity of several characteristics; degree of heterozygosity of the most important economic species, etc.
4) *Breeding work:* improvement through individual selections, line-breeding, and hybridization to obtain more and better firewood per area, to improve the quality of the wood for industrial uses and to get increased resistance to diseases and insects.

**British Guiana:** — The following is extracted from a personal report kindly furnished to the author by C. HOLMAN B. WILLIAMS, in charge of breeding work at the Sugar Experiment Station of the Department of Agriculture of British Guiana.

*Sugarcane.* — Soils for sugar-cane growing in British Guiana are usually heavy and very acid clays and silts; rainfall averages about 100 in. per annum, the distribution being very irregular. Harvesting takes place twice a year (February-May and September-December), and plant canes are reaped at 12-14 months and ratoons at 11-12 months. Fortunately all the sugar-cane diseases are absent and the question of immune varieties does not exist.

In 1889 the first seedling canes were introduced from Barbados to British Guiana; from that year until 1919 HARRISON and his collaborators (FRANCIS, JENMAN, STOCKDALE and WARD) maintained a steady program of cane breeding, collection, and selection. Thus, between 1896 and 1902, JENMAN and HARRISON germinated 313,900 seedlings. Their outstanding success, so far as British Guiana is concerned, was D.625, bred in 1892 from a cane known as Dyer. By 1924, D.625 covered 70 per cent. of the cane acreage; it disappeared from commercial harvests only in 1941. Other varieties were, however, grown locally to some extent, and several earned fame abroad. The Louisiana industry depended for many years on two Demerara seedlings, and as late as 1931 there were 42,400 acres of D.1135 in Hawaii.

Since 1919 the British Guiana Sugar Planters' Experiment Station has been responsible for most of the breeding work with sugar cane, from that year until 1929, CRABTREE and WHITTLES were in charge. From 1929 to the present time, WILLIAMS and CAMERON have carried on the work.

For many years the objective was a cane which would stand up to local conditions as well as D.625, and yield more sugar per acre. Careful field tests, conducted on a Colony-wide basis since 1930, have indicated that D.666/18, D.628/21, D.927/22, D.9/28, and D.11/28 could have replaced D.625 with advantage, but experimentation and commercial testing had not, prior to 1930, kept pace with breeding; by the time these facts were known these canes and two still better ones (D.49/30 and D.66/30) had been replaced

by a new introduction, P.O.J. 2878, whose superiority to all competitors then available was very marked.

Mention must also be made of a cane, Diamond 10, bred at Plantation Diamond, a concern which has for years maintained breeding on a small scale. This cane gained popularity in the '30's at the expense of D.625, and reached a peak of 43.5% of the acreage in 1939. In that year it was overtaken by P.O.J. 2878, which has continued to expand, while Diamond 10 has now declined to 26.53% of the acreage. Of the area to be harvested in 1943, 67.96% is listed as being under P.O.J. 2878.

It is of interest to note that imported noble canes have usually failed under the peculiar soil and climatic conditions of the Colony and that P.O.J. 2878 is the first outstandingly successful importation. Likewise it now appears that there will be no great progress so long as the breeding is confined to noble parents. Since 1933, however, Glagah and Chunnee strains have been introduced into the local breeding program, and Sorghum has also been used. As a result it has been possible to advise the extension of:

| | | | | |
|---|---|---|---|---|
| D. 14/33 | Parents | Co. 281 | × | Diamond 10 |
| D. 419/33 | — | — — | × | — — |
| D. 14/34 | — | — — | × | — — |
| D. 166/34 | — | P.O.J. 2878 | × | Sorghum |
| D. 200/36 | — | — — | × | Co. 213 |

Planters are developing these canes rapidly. It is confidently expected that when they are fully extended, the average yield of the Colony, which has already doubled itself in twenty years as a result of new varieties and improved field and factory methods, will rise by a further 25%.

*Rice.* — Experimental work on rice by the Department of Agriculture began in 1902 when a large number of varieties was imported. However, owing to an inadequate staff and the importance of the sugar industry, the purity of these strains could not be maintained. Many further importations were made between 1902 and 1910, and some hybrids were produced in 1910 and 1915, but most of the importations were lost.

In 1927 E. M. PETERKIN and J. INDROBEHARRY concentrated first on a large number of single-plant selections and the elimination of those whose progenies showed signs of red grains or awns. Progeny rows of the most promising types were established and the distribution of pure-line seed organized so efficiently that in a few years the highly heterogeneous commercial plantings had been largely replaced by three well-defined five-months types; *viz.*, Demerara Creole, Blue Stick, and No. 79.

L. E. W. CODD, and more recently C. H. B. WILLIAMS and P. A. CHAN-CHOONG have continued the selection work. Many varieties have been imported, acclimated, and tested, and a great deal of hybridization carried out. As a result, D.110, of medium-length grain and very drought-resistant, is now replacing Demerara Creole and No. 79, and still better strains are being recommended for commercial extension.

The recent tendency to introduce machines for reaping and threshing has brought the question of stiff straw to the fore, and selections of non-lodging types are now being made.

The "Agricultural Journal of British Guiana" is the best local Journal in which most of the results of the experimental work conducted there are published.

**Chile:** — This South American country, because of its peculiar shape — extending as a long and narrow strip between the Andes and the Pacific Ocean, over 4.000 km long by 170 to 350 km broad — has an extremely interesting agriculture, located mostly in separate valleys on the western slopes of the Andes. Depending upon the latitude (from 18° to about 55°) and altitude, various economic plants are cultivated, mainly wheat and many fruit plants, such as grapes, peaches, etc. The wine industry becomes more important every year.

Plant breeding work is carried out at two institutions: "Estación Experimental de la Sociedad Nacional de Agricultura" and "Departamento de Genética y Fitotécnica" of the Ministerio de Agricultura. In the first, breeding of wheat and barley is done by J. CASTILLO, and work with forage plants is conducted by E. BUCHNER. During the period of 1933-39 many wheat crosses were made by M. ELGUETA, now the director of the above-mentioned Genetics Department; at present the best strains, already homozygous for most characteristics, are being investigated in detail.

In the Departamento de Genética e Fitotécnica eight of its assistants are concerned with the breeding of various economic plants (wheat, fiber and oil plants, maize, rice, potatoes, field beans, and several vegetables), and Miss CARMEN SANZ is devoted to cytogenetic investigations. Each of these projects is concerned with the solution of special problems, most of them having been organized in 1939. The Department maintains twelve regional experiment stations located at the various agricultural zones of the country.

Several members of the staff have been carrying on advanced studies in the United States. Recently H. K. HAYES, the noted American plant breeder, has helped promote the use of modern methods in plant breeding and genetical research by giving a special course on these subjects at Santiago, while on a short visit in this country.

**Colombia:** — Colombia is the largest country in northern South America, its territory being divided by three subdivisions of the Andes. Agriculture is diverse, the lowlands cultivating such tropical plants as rice, corn, sugar-cane, etc., and the mountains being famous for their coffee plantations situated between 1,000 to over 2,000 m. altitude.

Breeding work is carried out with the following crop plants:

*Coffee.* — Colombia is the second largest coffee producing country in the world, its industry being controlled by the "Federación Nacional de Cafeteros." It maintains one experiment station at Chinchiná (Caldas) and small demonstration stations in nine other coffee growing regions. E. LATORRES HOYOS, at present at the University of California, Berkeley, will be in charge of coffee breeding; so far only some preliminary investigations have been carried out.

*Sugar-cane.* — At the Palmira Experiment Station which is ideally situated for sugar-cane breeding because it is possible to have the cane flowering nearly throughout the year, extensive breeding work has been conducted by G. RAMOS NUÑEZ in coöperation with the U. S. Department of Agriculture (E. W. BRANDES, G. B. SARTORIS, JULIUS MATZ, and H. G. SORENSEN). The objects of this work, which was begun in 1938, are as follows:

*a.* to transfer cold resistance of *Saccharum spontaneum* from Turkestan types to *S. officinarum* varieties. Many seedlings derived from these crosses have been grown in the southern United States, and the best selections are said to be very promising. Cold resistance is not important for Colombia, but some early types from these hybridizations might be of possible value to certain sugar-cane regions. The fourth generation of these crosses has already been studied, about 30,000 seedlings having been grown in the nurseries.

*b.* to breed new varieties by crossing several cultivated varieties, specially adapted to the ecological conditions prevailing in the sugar-cane regions; some of these new clones are now compared with the old standard varieties.

*Rice.* — A large collection of varieties has been established at the Palmira Experiment Station, and selection and hybridization work is being conducted there by G. LÓPEZ to breed new varieties especially adapted to the rice growing lowlands of Colombia and resistant to the "Helminthosporiasis" disease.

*Fruit trees.* — M. F. RIVERos of the Palmira Experiment Station has devoted himself to the study of various tropical and subtropical fruit trees, mainly *Citrus* and avocados. Many crosses between *Citrus*

species and varieties have been made and individual selections are now being compared with standard varieties.

*Wheat and other small grains.* — Near Bogotá the government established La Picota Experiment Station primarily to work with several small grains (GERVASIO OBREGÓN and co-workers). Good collections of wheat, barley, and oats were gathered, and new wheat varieties resistant to *Puccinia graminis* and *P. glumarum* have been isolated through selection and hybridization (Bocas 3215-F-7-1, Borew 4652-D, Bola, Marzudo, etc.). A well equipped laboratory to test the flour quality is cooperating in this work.

*Potatoes.* — At the Cajicá Experiment Station interesting work with potatoes has been done during the last two years by L. NAVARRETE. Many wild types pertaining to several species of *Solanum* and also cultivated varieties have been collected, and numerous crosses made in an attempt to breed new varieties resistant to diseases, with high yielding capacity and tubers of good quality.

*Cotton.* — Improvement work with *Gossypium hirsutum* cotton is carried out at the Cotton Station at Armero (Tolima), seeds of the best strains being distributed to the farmers.

**Paraguay:** — In this South American republic much is being done at present to modernize its agriculture. With the coöperation of North American and Brazilian specialists, teaching in its agricultural college "Mariscal Estigarribia" has improved and a new research institution which will be engaged in various investigations and also do extension work has recently been founded.

So far plant breeding is carried out only at the Agricultural College by H. DINIZ DE FREITAS (cotton and tobacco), but improvement of other economic plants, such as manioc, maize, peanuts, sweet potatoes, sugar cane, and rice, is planned at the new Institute (HILÁRIO MIRANDA of the Instituto Agronômico of the State of São Paulo, Brasil).

**Perú:** — Plant breeding work in Perú has made considerable progress in the last ten years and is at present being carried on in the following experiment stations: Estación Experimental Agrícola de La Molina with its Sub-Stations located at Piura in the northern part of the country, Estación Experimental Agrícola del Norte (Lambayeque), Estación Experimental de la Asociación de Hacendados de Cañete and the Estación Agrícola de Junin at Concepción, the last one located at 3,250 m altitude. Besides these stations, the Sociedad Nacional Agraria at Lima maintains a Genetics Department for cotton research, at present under the direction of S. C. HARLAND, noted British geneticist. The best equipped Genetics Department is located at La Molina, according to TEODORO BOZA BARDUCCI, its director; four other geneticists (F. VACARI, R. BEINGOLEA, J. MONTESINOS, and A. GUEVARA) are working there too.

Breeding work and related research with the following economic crop plants is carried out at these stations.

*Cotton.* — At La Molina considerable work has been done since 1931 with the *Tanguis* variety, well known for its excellent fiber qualities. By the pedigree breeding method the new strain, "Tanguis L. M. no 7-35," has been isolated, because of its superior quality and earliness, it has replaced the common variety on 30% of the cultivated area in the year 1942/43; certified seed of this strain is produced on cooperative multiplication plots of the Agricultural College. Special emphasis is at present laid on the isolation of other lines which are more resistant to the wilt fungus, *Verticillium* sp.

Many crosses are made every year. For that purpose a world collection of cottons which comprises about 500 different types is used. The main object in this hybridization work is to obtain new commercial types resistant to insects (*Aphis* sp., *Empoasca* sp., etc.), and with good plant characters, and furnishing good yields and high quality cotton.

Also, systematic investigations have been conducted with the wild Peruvian cotton *Gossypium raimondii* Ulbrich by Prof. BARDUCCI (Bol. no 22 of the La Molina Station 1941).

Cytological work has been in charge of Prof. R. M. MADOO, formerly of the Trinidad Cotton Station, who has been also interested in chromosome duplication with colchicine.

In the north of Perú, at Piura, one of the important cotton producing regions, special breeding work is done with Pima and Acala cottons (L. VEGA BANCALARI). Large plots are planted every year to multiply selected strains.

At the Cañete Experiment Station particular attention is devoted to the breeding of *Aphis*-resistant Tanguis cotton, as this insect causes considerable damage in this cotton growing valley.

*Rice.* — The old variety "E.A.S. no 3" of Spanish origin has been replaced by new strains isolated from the "Borbon" variety at the Lambayeque Experiment Station (E. TRINT G.). Improvement through hybridization has also been started, and an attempt is being made to breed still better varieties of irrigated and upland rice.

*Wheat.* — At the Junin Experiment Station, 3,250 ms. above sea level, small grain improvement is carried out, particularly with wheat (C. TANTALEAN). From the Italian "Mentana" variety several superior strains which are highly resistant to *Puccinia glumarum* have been isolated. Many wheat hybrids (now $F_3$'s) are also under observation; of these several seem to be very promising. Some selection work is also done with oats and barley.

At La Molina wheat improvement has been also conducted for the last four years. A large collection of about 800 types was gathered from most other wheat producing countries, and special emphasis was laid on the isolation of strains resistant to *Puccinia graminis tritici*, which has almost prevented wheat growing at the coast region of Perú. A selection made in 1932 from an Argentine variety, "38 M.A. × San Martin 28," has been very successfully grown at that region for the last few years; it has been very helpful in increasing wheat production in Perú.

*Potatoes.* — Work is done at La Molina with *Solanum andigenum*, of which numerous types are native to Perú and many have already been improved and cultivated by the Indians. Besides taxonomic investigations, several of these types are subjected to selection and hybridization to isolate commercial varieties especially adapted to various ecological conditions. Many American and Canadian varieties of *S. tuberosum* have also been introduced for cultivation at the coastal region.

Besides the above-mentioned crop plants, several others, such as flax, hemp, etc., are used for breeding work at the La Molina Station.

The principal local publications on agriculture and related subjects are the following: "Boletin de la Dirección de Agricultura y Ganadería," and "La Vida Agricola," both edited at Lima. Besides these, official government reports and bulletins have published the results of local breeding and genetical work (Bulletins of the "La Molina" and other exp. stations). In "Flora and Fauna Peruanas" (Ministerio de Fomento) interesting papers on Peruvian flora and fauna have been published.

**Uruguay:** — This is the smallest South American republic, it covers a territory of a little less than 187,000 square kilometers, and has a mild temperate climate. Its agriculture and animal industry are well organized, their products being well known on various foreign markets.

"La Estanzuela," located at the Departamento Colonía, is its famous institution devoted to agricultural research; its director, Dr. ALBERTO BOERGER, must be considered one of the pioneers in plant breeding in South America. Since

1912 this institution has been working with the acclimatization of numerous foreign plants and the improvement of those which are of special economic interest. It owns extensive experimental grounds, greenhouses, and well equipped laboratories, and has a small but well trained staff of technical workers.

*Wheat.* — The first new wheat varieties distributed to the farmers (Pelón 33c and Americano 44d) were obtained by the pedigree method and are derived from old locally grown varieties; they succeeded in increasing the yield by 30 and up to over 100% when compared with the old unselected varieties.

Later on, extensive hybridization work was started, many local and imported varieties having been used for crossing; high yielding capacity, elasticity of date of sowing, resistance to diseases, and special economic charateristics were the main factors of selection. The best varieties developed through this work are "Artigas" (1924), "Larrañaga" (1926), "Centenario," "Renascimiento," and "Porvenir" (1933).

Another group of varieties, called "Litoral," has been developed to guarantee good yields under special environmental conditions and produce grains of high quality. To this group belong the following varieties: "Litoral," "Litoral 1," "Litoral 2," "Pelón Plateado," and "Litoral Precoz," the last two being especially adapted to late sowing.

*Maize.* — Mass selection has been practised for many years in local heterogeneous varieties; the following new types have been developed: La Estanzuela Amarillo, Cuarentón, and Colorado. Lately a new breeding project to isolate pure lines to be used for the production of hybrid corn varieties has been started. For this purpose only two varieties, Cuarentón and Colorado, have been selfed.

*Oats.* — As the consumption of this cereal is constantly increasing in Uruguay, special attention has been paid by this institution to breeding new and always better varieties. Two very good strains have been developed: "La Estanzuela 64s" and "La Estanzuela 1095a," the first one belongs to *Avena sativa* and the other to *A. byzantina*. Through the crossing of these two species a new type of special economic interest, "La Estanzuela $F_2$ au 12", which is now being distributed to the farmers was obtained.

*Barley.* — Two main types of barley are grown in Uruguay, one being used in the beer industry and the other for forage purposes. Extensive breeding has been practised and new varieties which successfully replaced the old ones have been developed.

*Oil-flax.* — Several periods of improvement of this plant have occurred at La Estanzuela. In the beginning three lines which outyielded the local variety by 13% in seed production were selected; in 1920 a new line which outyielded the others by 5% was developed. From 1923 on special attention was paid to the breeding of varieties which could be grown repeatedly in the same soil for several years (linos "repetibles"). From the three best varieties "La Estanzuela 117" is grown most extensively at present.

*Fiber-flax.* — By crossing certain lines with high oil-content with others previously selected for fiber the hybrid "La Estanzuela E," which seems to be promising for the textile industry, was developed.

*Sunflower* (*Helianthus annuus*). — After several years of breeding work, a new variety of sunflower, "La Estanzuela 30," was launched in 1940; it is superior to the old varieties in uniformity (single headed), yielding capacity, and oil content.

*Forage plants.* — Considerable breeding work has been done lately to improve the main forage plants of Uruguay, as the animal industry is very important to that country.

We see that several outstanding new plant varieties have been developed at La Estanzuela. This is mainly due to the fact that breeding work was started as early as 1912, much before any other agricultural institution began work along similar lines (with the exception of British Guiana), and also because La Estanzuela has been lucky in having had A. BOERGER as its director for over 30 years. He succeeded in building up a staff of efficient Uruguayan workers who are now carrying out research on various lines. GUSTAVO J. FISCHER has been one of his main collaborators; J. G. DELLAZOPPA, J. B. FREIXA, T. HENRY, M. CANEL, and others have also helped.

Besides numerous technical articles which appeared in local and European journals, BOERGER published in 1928 a book, "Observaciones sobre Agricultura; Quince años de trabajos fitotécnicos en el Uruguay" (Imprenta Nacional, Montevideo) and recently three volumes of "Investigaciones Agronómicas" in which most of the breeding work done at La Estanzuela is summarized (A. BARREIRO Y RAMOS S.A., Montevideo).

Outside La Estanzuela little work is done on plant breeding, genetics, and cytology in Uruguay. At the Genetics Division of the Facultad de Agronomia at Montevideo, cytological investigations have been made by R. C. LÁZARO on *Helianthus annuus;* the somatic chromosome number was determined to be $2n = 34$. At this Division several other investigators, among them GUSTAVO SPANGENGERG, are doing work on plant genetics and breeding.

**Venezuela:** — Since the Department of Genetics was formed in 1939 at the "Instituto Experimental de Agricultura y Zootecnia" of the Ministerio de Agricultura y Cría, outstanding work in plant breeding and genetics has been carried out in this South American country. D. G. LANGHAM, a Cornell graduate, has been in charge of all work, he is now assisted by E. A. WEAVER and several young enthusiastic Venezuelans who are trained in plant breeding and genetics.

The following account has been extracted from a personal report to the author, kindly prepared by LANGHAM:

"The main project of the Department of Genetics is the development of improved seeds of important crop plants and the distribution of these seeds to the farmers of this and other countries of the same latitude.

"*Maize.* — A preliminary survey of the existing corn varieties in Venezuela showed that all of them were inferior and had a tendency to grow extremely tall, with the ears high on the stalk. Most varieties had white seeds, primarily because the people depend to a large extent on "arepas," ground corn in the form of a small, thick pancake, for food. Yellow "arepas" are preferred in some regions of the country, but white ones are most commonly used.

"In an attempt to improve corn production, the best varieties and hybrids from the United States and from many tropical and subtropical countries, including Cuba, Puerto Rico, Santo Domingo, and Colombia, together with Venezuelan varieties, were planted at three different experiment stations. The types from the United States proved unsatisfactory. The best corn of the whole group was a mixture of two varieties from Cuba. This type was planted in a separate field, and six generations of mass selection have resulted in a high-yielding corn which is now being distributed under the name of VENEZUELA-1 in this and neighboring countries. It is estimated that if all the farmers planted VENEZUELA-1 in place of the local varieties, the corn production of the country would be increased by more than 100%. Many farmers are now using it and more seed is being distributed.

"A modern program for the production of hybrid corn has been carried on simultaneously with this project. Approximately three hundred Venezuelan hybrids are being tested this year, some of them are undoubtedly superior to VENEZUELA-1. The best ones will be distributed within the next few years.

"*Sweet corn.* — Until recently, Venezuela had no sweet corn of its own, and none of the imported varieties gave desirable ears. Several years ago, however, a few kernels of sweet corn were found here in a field of ordinary field corn adapted to these climatic conditions. These kernels of sweet corn were planted separately and crossed with the improved VENEZUELA-1 to obtain vigor and other useful character-

istics. In the following generations of selection a pure breeding sweet corn has been developed and is being distributed under the name of VENEZUELA-2. It has been widely accepted and is eaten with "mucho gusto."

"*Sesame* (*Sesamum indicum*, Loew.). — This plant is a valuable source of vegetable oil which can be substituted for olive oil and used as a seed in preparing refreshing drinks and making confections. Several years ago the Department of Genetics made a collection of varieties from India, Colombia, China, Honduras, Guatemala, Nicaragua, Mexico, Brazil, and other countries, and began cross-breeding for the purpose of obtaining high-yielding varieties. As a result of this hybridization and selection, many new types which give higher yields under these conditions than any other variety have been obtained. The improved types are being propagated on a large scale, and seeds are being sent to many countries for testing. The cross-breeding of these varieties has given an opportunity to study the mode of inheritance of contrasting characters in sesame. The results of the investigation of fourteen characters are being prepared for publication. Sesame has also been treated with colchicine and various polyploids were obtained.

"*Cotton, rice, potatoes and castor beans.* — In cotton and rice, the major work at the present time is testing imported varieties to see which ones are best suited to our conditions and then distributing those particular varieties while new ones are being developed. In potatoes the high-yielding varieties from the United States are being crossed with the wild varieties of Venezuela in an effort to combine the commercial qualities of the imported varieties with the disease resistance of the local varieties. Similar work is being done in castor beans. More specifically, a dwarf type from Brazil with low oil content has been crossed with local types for the purpose of obtaining dwarf plants with no spines on the seed pods, a high oil content, quick maturity, and disease resistance. The dwarf character facilitates harvesting, and the spineless character not only lessens the damage to the hands of the picker, but also seems to be associated with a resistance to a destructive fungus disease."

The results of these and other investigations have been published in "Science," "American Journal of Botany" and in various "Circulares" of the Departamento de Genética del Instituto Experimental de Agricultura at Caracas. Two other Venezuelan periodicals on agriculture are "El Agricultor Venezolano" and "Revista del Instituto Nacional del Café," both edited at Caracas.

## CENTRAL AND NORTH AMERICA

Excluding Mexico, which covers a large territory (nearly 2 million km.$^2$), much of which is located in the North American continent, Central America is composed of several small countries, which connect North and South America. Most of them are mountainous, their lowlands bordering the Atlantic and Pacific Oceans, where the climate is tropical. At higher altitudes average temperatures are much lower, a condition which makes it possible to cultivate a great diversity of crop plants in most of these republics.

Plant research, with a few exceptions, is here still just beginning; only a small number of institutions is carrying out some breeding work and practically no references could be found by the author to investigations in genetics and cytology.

**British Honduras.** — In this small British colony extensive research work with bananas has been carried out by the United Fruit Company, but apparently very few published accounts are available.

Banana plantations have been severely damaged in this colony by two diseases: the "Panama disease," caused by *Fusarium cubense*, and the "Leaf spot," caused by *Cercospora musae*. The "Gros Michel" variety, of excellent eating and shipping qualities, is extremely susceptible to both of them and great efforts are being made to breed new resistant types. This breeding work is, however, very difficult, as edible bananas are parthenocarpic triploids and occasional hybrids with seedy resistant diploids usually lack good eating qualities. To transfer resistance from other edible varieties to the "Gros Michel" is also difficult because of their triploid constitution.

**Costa Rica:**—This small republic covers an area of only 59,500 km.$^2$ and offers particularly favorable conditions for plant research of general interest to the Americas. This is the reason why it was decided to locate the new "Panamerican Institution for Plant Research," recently inaugurated by Vice President HENRY WALLACE, in this country. At various altitudes, from sea level to almost 4,000 meters, all sorts of tropical, subtropical, and temperate crop plants can be successfully grown, this condition makes it possible to carry out a very diversified program of plant investigations, including genetics, cytology, and breeding.

Coffee, the principal cultivated plant in this republic, is famous for its excellent quality; this is the result of special methods of picking and handling the coffee before it is exported. Apparently no breeding work is carried out to improve the yielding capacity of the plantations, which is rather low. In this country a new variety of coffee, the "San Ramon," originated, apparently by mutation from one of the common *C. arabica* varieties; it does not seem to have been cultivated yet, in spite of the fact that it has certain advantages over the other varieties, having a semi-dwarfed growth habit and good yield.

At Turrialba the U. S. Department of Agriculture is maintaining a Rubber Breeding Station where much work has been carried out.

**El Salvador:** — This is the smallest country of Central America, covering a territory of only 34,000 km.$^2$; its chief crop plant is coffee, which is cultivated at three distinct regions. The "Asociación Cafetalera de El Salvador" is conducting some research with coffee primarily at the experimental farm "La Ceiba" in the neighbourhood of San Salvador. FELIX CHOUSSY, specialist in coffee, is in charge of these investigations, which include variety testing and improvement.

**Guatemala:** — Coffee is one of the main cultivated plants in this small Central-American country too; various investigations are being carried out there to improve the yielding capacity and quality of its product. Mr. JUAN ANTONIO ALVARADO has been in charge of this work for many years. In 1935 and 1936 he published two books on coffee (Tratado de Caficultura Práctica. — Tipografia Nacional). Some breeding work is also conducted by a private plantation owner, Mr. BUCHHOLZ, who has crossed the *maragogipe* variety with both the *bourbon* and the *typica* varieties in an attempt to improve the yielding capacity of the former. The hybrids are vigorous and morphologically identical to the maragogipe, as this "gigas" form is due to one dominant gene (C. A. KRUG and ALCIDES CARVALHO).

More recently, in coöperation with the U. S. Department of Agriculture investigations with quinine (*Cinchona* sp.) have been conducted in an attempt to build up a new course of quinine in this country.

**Mexico:** — The Secretaria de Agricultura y Fomento, with headquarters at San Jacinto, México, D.F., maintains an extensive system of experiment stations in the country, where general experimentation with several crop plants is conducted, including considerable plant improvement work.

Major attention is devoted to maize, which occupies almost two-thirds of the cultivated land and is the staff of life of the Mexican people. Extensive variety tests of local strains are being conducted, and the more productive are increased and distributed to growers. Inbreeding is practised on a large scale; more than thirty thousand pollinations are made annually. Inbred strains and hybrids from the United States have been included in these tests. Several promising inbred lines have been identified. The corn breeding, under the direction of EDMUNDO TABOADA, is conducted at field stations throughout the country. Much of the work is centered at León in the state of Guanajuaro and is in charge of EDUARDO LIMON.

A second important plant breeding program in Mexico is devoted to the development of rust-resistant varieties of wheat. Physiological cases of rust which occur in Mexico are being identified by inoculations. Rust-resistant varieties from all parts of the world are being tested and the hybridization of imported rust-resistant strains with local varieties has already been initiated.

Variety tests of soy beans, castor beans, sesame, sugar cane, and other crop plants are now in progress as a step preliminary to the breeding work.

### West Indies

Investigations on genetics, cytology, and plant breeding in the West Indian islands are mainly carried out at Barbados, Jamaica, Puerto Rico, and Trinidad.

**Barbados:** — This British island is well known to plant breeders for its outstanding work on sugar-cane improvement research. In its Agricultural Department many thousands of seedlings have been raised, derived from selfings and crossings (A. E. S. MCINTOSH in charge). Sugar-cane varieties grown at this island have often been replaced by new selections, and many of the Barbados canes have also been successfully grown at other places, mainly at other British West Indian islands. The breeding work is concerned mostly with the nobilization of such wild canes as *Saccharum barberi*, *S. spontaneum*, *S. sinense*, etc.

Breeding work is also conducted with sweet potatoes and cotton to breed superior strains.

**Jamaica:** — At the British island special attention has been devoted to banana breeding and cytology, L. N. H. LARTER, Government botanist, having been in charge. Several articles on the cytology of *Musa* have been already published by this specialist (in *Journal of Genetics*), who is concerned mainly with the breeding of types resistant to the "Panama disease" and "leaf spot" (*Cercospora musae*), in Trinidad and British Honduras. R. LEACH, Plant Pathologist of the Banana Leaf Spot Control Division, has done outstanding work on this disease, having recently discovered the sexual stage of the fungus which was called *Mycosphaerella musicola*.

Some improvement work is also done with other economic plants by several government specialists.

**Puerto Rico:** — Two Agricultural Experiment Stations are doing plant research work at this American island, one at Mayagüez (U.S.D.A.) and the other at Rio Piedras under the supervision of the University of Puerto Rico.

At Mayagüez various investigations of coffee have been carried out, particularly by T. B. MCCLELLAND, now in charge of the Coconut Plant Introduction Garden near Miami, Florida. Recently also renewed attempts were made at this Station to grow quinine, several *Cinchona* species having been imported through the Division of Plant Exploration and Introduction of the U. S. Department of Agriculture, as it is thought that this island offers favorable environmental conditions for the cultivation of this important medicinal plant.

Good work has also been conducted here in sugar-cane breeding, the "M" (Mayagüez) canes being well known also in other countries (R. L. DAVIS). Field corn and sweet corn have been improved by selection and hybridization and seeds distributed to the farmers.

The Agricultural Experiment Station (former Insular Experiment Station), established in 1910 by the Asociación de Produtores de Azúcar de Puerto Rico and since 1914 a government institution, is now part of the University of Puerto Rico. Its Director is J. A. B. NOLLA, a Cornell graduate. For many years this station has been actively engaged in breeding and genetical investigations, particularly with the following economic plants of this island.

*Cotton.* — Since 1931 the sea-island cotton has been subjected to improvement work and a new strain which has 25% lint and a staple length of about two inches has been developed (J. P. RODRIGUEZ). At present the Puerto Rico Cotton Growers Coöperative Association is producing the seeds of this strain under the supervision of the experiment station.

*Coffee.* — In spite of the fact that coffee cultivation in Puerto Rico has been of only minor economic importance, extensive research on varieties, methods of cultivation and harvesting, diseases and insect pests, and on the physiology of the coffee plant has been conducted at this station. Among the varieties of *Coffea arabica*, the *columnaris* has been outstanding in yielding capacity; farmers are now advised to give this variety a good trial.

*Sugar-cane.* — To breed new varieties of sugar-cane resistant to mosaic and with high sugar content has been the aim of the breeding work at Rio Piedras. Many varieties have been introduced from abroad, tested at regional stations (P. RICHARDSON and A. ROQUE), and thousands of seedlings derived mainly from crosses between noble and wild canes (*Saccharum robustum* and *S. spontaneum*) imported from Java and other countries raised. In 1939-40 a new program of hybridization was started (A. ROQUE); about 100 crosses were made, using primarily the following parents; M-28, POJ-2878, PR-803, and Santa Cruz 12 (4). Over 12,000 seedlings were raised. At regional trials, mostly located at eleven sugar mills, the best clones are tested every year in comparison with the cultivated varieties.

*Tobacco.* — The station's work in tobacco is now limited to economic studies, all other work being done by the Tobacco Institute. Dr. J. A. B. NOLLA, however, has carried out important investigations of the inheritance of various characters and also of mosaic resistant types of *Nicotiana* (in coöperation with A. ROQUE).

*Corn.* — Native field corn has been subjected to selection and inbreeding; at present efforts are being made to produce a new synthetic variety combining several single and double crosses derived from seven inbred lines (A. ROQUE and G. A. LEBEDEFF). The heredity of about forty different abnormalities, which appeared after selfing, is also being investigated.

*Field beans.* — The station has been successful in selecting among native beans superior high yielding strains; four of them have already been released for general cultivation.

*Cucumbers.* — A new strain which is resistant to the downy mildew (*Peronoplasmopara cubensis* B. and C. Cinton) was developed and efforts are now being made to introduce mosaic resistance as well to this strain.

*Pepper.* — By crossing American varieties susceptible to mosaic, several resistant lines which certainly will contribute to increase the production of pepper in this island have been isolated.

**Trinidad:** — At this island of the British West Indies important plant research has been carried out for many years at the Imperial College of Tropical Agriculture, both at St. Augus-

tine and at the Empire Cotton Growing Corporation's Research Station.

The following is part of a personal report which E. E. CHEESMAN, noted plant geneticist and breeder of the Imperial College of Tropical Agriculture, recently sent to the author:

"*Bananas.* — In bananas the economic requirement is the production of a genotype resistant to diseases—especially banana wilt caused by *Fusarium cubense* and the leaf spot caused by *Cercospora musae.* Resistance has to be combined with the various qualities essential in a commercial banana grown for an export market, and this is the difficult part of the problem. Commercial bananas being sterile, parthenocarpic polyploids, inheritance in the group is exceedingly complex, and cytogenetical investigations have an important place in the program.

"The I.C.T.A. maintains a type collection of banana varieties and *Musa* spp. and concentrates on the genetical and cytological side of the researches. Here K. S. DODDS has for several years been studying parthenocarpy, sterility, and polyploidy in the group. Large scale banana breeding is carried on in Jamaica by L. N. H. LARTER.

"*Cacao.* — With cacao crop improvement is at a simpler stage. All cacaos are to some extent heterogeneous, but Trinidad cacao is one of the most mixed populations in the world. Thus, when intensive research on the crop was started at the I.C.T.A. in 1930, the first steps were to select a limited number of good trees and to establish them as clones. A genetical survey of Trinidad cacao upon which selection could be based, and the selection itself, were carried out by F. J. POUND, now agronomist in the Trinidad Department of Agriculture. The early studies of vegetative propagation were made by E. E. PYKE, and from them a technique for establishing cacao clones on their own roots (by cuttings) has been worked out on a practicable commercial scale. At the present time the comparison of clones in statistically planned field experiments is proceeding, and interesting differences in clonal behaviour are becoming apparent.

"Studies of pollination and fertilization have revealed the frequent occurrence in Trinidad cacao of a kind of self-incompatibility, which is quite different in nature from the self-incompatibility shown by some temperate fruit trees. This is receiving further investigation.

"A serious economic problem facing the Trinidad cacao industry for the last ten years or more is the control of witches' broom disease (caused by *Marasmius perniciosus*). The only practical solution seems to lie in the discovery of a variety of cacao resistant to the disease; the Trinidad Department of Agriculture has been making efforts to that end. F. J. POUND visited Ecuador in 1937 and the headwaters of the Amazon in 1938 and again in 1942 in search of resistant trees; he has succeeded in locating some very promising types which are now being tested."

The Empire Cotton Growing Corporation's Research Station has done most outstanding work on cotton genetics, cytology, and breeding, both when S. C. HARLAND was in charge of the station, and at present under the direction of J. B. HUTCHINSON, R. A. SILOW coöperating. With these investigations fundamental knowledge concerning the heredity of many characters, and the cytogenetic relationships of the species of *Gossypium* has been gained; some of this research has also contributed to formulating new conceptions regarding the evolution of dominance. The cytological work has been carried out mainly by A. SKOVSTED.

### GENERAL CONCLUSIONS

In spite of the fact that some outstanding work has already been done at several Latin American institutions in genetics, cytology, and plant breeding, one should not forget that an enormous number of problems are still awaiting attack, most of the work so far completed being primarily of a preliminary nature. Latin America is therefore as mentioned in the introduction, an open field to geneticists, evolutionists, cytologists, and plant breeders.

As a review of the data presented in the preceding chapters, it might be of interest to present here a short summary and a few general conclusions.

In South America the countries leading in these sciences are Brazil, Argentina, and Uruguay. In the first of them outstanding work on genetics, cytology, and breeding is conducted at the Instituto Agronômico do Estado de São Paulo, at the Escola Superior de Agricultura "Luiz de Queiroz" of the University of São Paulo, and in the States of Minas Gerais, and Rio Grande do Sul. In the Argentine the Instituto Fitotécnico de Santa Catalina and the Instituto de Genética of the University of Buenos Aires are carrying out excellent investigations in the same fields, and the Tucumán Experiment Station is well known for its breeding work. Uruguay has its famous "La Estanzuela" Experiment Station, where pioneer breeding work has been done for many years.

In the West Indies the following islands are doing the best work, mainly on plant breeding and genetics: Trinidad, Puerto Rico, and Barbados.

Reviewing the data according to the major economic plants, one concludes that the following countries and islands are conducting the most outstanding investigations:

| | | |
|---|---|---|
| *Bananas* | Cytology and breeding | Trinidad, Jamaica and Guatemala |
| *Cacao* | Breeding | Trinidad |
| *Castor beans* | Genetics and breeding | Brazil |
| *Citrus fruits* | Breeding | Venezuela |
| | Cytology and breeding | Brazil |
| *Coffee* | Genetics, cytology and breeding | Brazil |
| *Cotton* | Genetics, cytology and breeding | Trinidad and Perú |
| | Breeding and cytology | Brazil |
| | Breeding | Argentine, Colombia and Puerto Rico |
| *Eucalyptus* | Genetics, cytology and breeding | Brazil |
| *Flax* | Breeding | Uruguay, Argentine and Brazil |
| *Maize* | Genetics, cytology and breeding | Brazil and Argentine |
| | Breeding | Venezuela, Uruguay and Puerto Rico |
| *Manioc* | Genetics, cytology and breeding | Brazil |
| *Potatoes* | Cytology and breeding | Argentine |
| | Breeding | Brazil, Colombia, Perú and Bolivia |
| *Quinine* | Breeding | Brazil, Guatemala and Puerto Rico |
| *Rice* | Breeding | British Guiana, Brazil and Colombia |
| *Rubber* | Cytology and breeding | Brazil |
| | Breeding | Costa Rica |
| *Sugar Cane* | Breeding | Barbados, British Guiana, Argentine and Puerto Rico |
| *Tobacco* | Genetics and breeding | Brazil and Puerto Rico |
| *Tung* | Breeding | Brazil |
| *Wheat* | Breeding | Uruguay, Argentine, Brazil, Colombia, Perú and Chile |

Many of the investigations outlined are recent. the majority of them having been started in the last ten to fifteen years. With the advent of modernized agriculture in Latin American countries and with the growing competition in local and foreign markets, it becomes increasingly necessary to improve the yielding capacity and the quality of the products of their principal agricultural crop plants. Therefore, the breeding of these plants and their genetical and cytological analysis will be of ever-growing importance in the future. Raw plant material for these investigations, either native or introduced, is easily obtainable, and well equipped laboratories and field facilities are already existent in many of these countries. The most important problem is, however, to get well trained and scientifically minded geneticists, cytologists, and plant breeders. Various investigators from abroad have done outstanding work in these fields in Latin America, as for instance, IWAR BECKMAN from Svalöv, Sweden, F. G. BRIEGER and ALBERTO BOERGER from Germany, S. C. HARLAND from England, and several North American workers like D. G. LANGHAM and others. Many local investigators have done post graduate studies at several universities of the United States, mainly at Cornell University, the Universities of Florida and California, Louisiana State University and Columbia University.

To build up good staffs of plant breeders, geneticists, and cytologists, the following steps should be undertaken in all Latin American countries: establishment of elementary and graduate courses in these sciences in all agricultural colleges which do not have them yet; improvement of the teaching in these fields in some of the other colleges where these sciences are already taught; encouragement of a greater interchange of investigators among all American republics and of Latin Americans to do graduate work at leading North American universities.

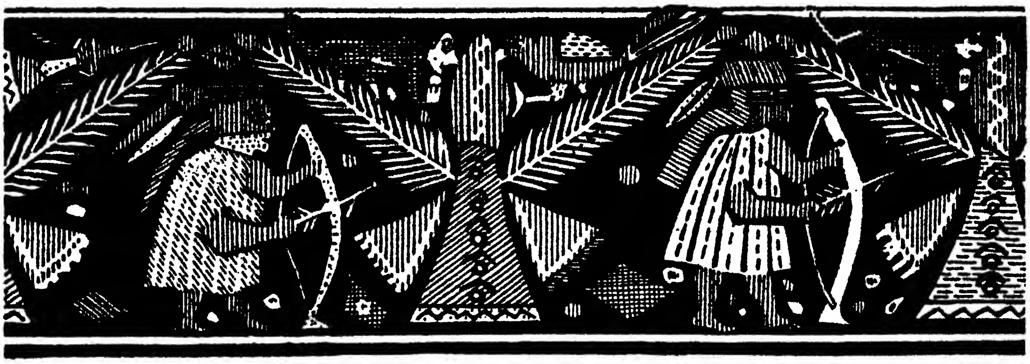
The war has brought all American republics closer together; it is hoped that this coöperation will also help promote a faster development of genetics, cytology, and plant breeding in Latin America, as these sciences are of so much economic and social importance to our continent.

Acknowledgments are due to the following investigators who furnished the author valuable data regarding the work being conducted on plant breeding, genetics, and cytology in their respective countries or states: *Argentine:* M. KUGLER; *Bolivia:* MARTIN CÁRDENAS; *Brazil:* A. B. FAGUNDES (Rio de Janeiro), L.O.T. MENDES (Pará), F. G. BRIEGER (São Paulo), A. GROSSMAN (Minas Gerais), HEITOR TAVARES (Pernambuco), J. A. SOUZA SOARES (Rio Grande do Sul), E. F. TEIXEIRA (Rio Grande do Sul); *British Guiana:* C. H. B. WILLIAMS: *Chile:* MANUEL ELGUETA; *Colombia:* O. BOTERO, G. R. NUÑEZ G. ZAPATA, G. OBREGON, and E. C. MISAS; *Paraguay:* HILARIO MIRANDA; *Perú:* TEODORO BOZA BARDUCCI; *Trinidad:* E. E. CHEESMAN; *Uruguay:* ALBERTO BOERGER; and *Venezuela:* D. G. LANGHAM.

# PARS II

THIS, THE SECOND PART OF "PLANTS AND PLANT SCIENCE IN LATIN AMERICA," CONSISTS MAINLY OF ARTICLES PREVIOUSLY PUBLISHED IN CHRONICA BOTANICA. SEVERAL OF THEM HAVE BEEN REVISED CONSIDERABLY.—*For a complete table of contents and index of names see pp. 350, seq.*

PLATE 26. — HOUSE OF A RUBBER COLLECTOR ON THE LOWER MADEIRA RIVER (BRAZIL). — *From* FRANZ KELLER, "The Amazon and Madeira Rivers" (London, 1874).



I. Ochoterena: **Outline of the Geographic Distribution of Plants in Mexico***:- Although extensive studies of the flora of Mexico were initiated in the 16th Century by Francisco Hernández, the study of plant geography was first undertaken in 1840 by Frederic Michael Liebmann, who made a collection of 4000 specimens and published the first phytogeographic papers. In 1842, M. Martens, associated with Galeotti, published in Brussels his studies on Mexican ferns including their geological and geographic distribution. Later on, many partial studies and attempts at a general comprehensive work appeared, of which those written by Ing. J. N. Rovirosa, Ing. Carlos Patoni and Dr. José Ramírez are outstanding.

Our extensive trips throughout the country for a number of years have led us to establish the following divisions based on the classification used by Dr. José Ramírez:

I. Coastal and Dune Region.
II. Tropical Region.
III. Subtropical Region.
IV. The Desert Regions:
   1. Arid sub-regions:
      a) of the N. of Sinaloa and W. of Sonora,
      b) of Lower California.
   2. Texan-Mexican sub-region of the N.
   3. Southern sub-region.
V. Region of the Central Plateau:
   1. Temperate and dry sub-region of the Southern plains.
   2. Hot sub-region of the S. of the "Mesa Central".
VI. Region of the "Sierra Madre".
VII. Cold, Slightly Humid Region of the Top of the High Mountains.

I. *Coastal and Dune Region*, with intermediate lakes and marshes and inland prairie. Belt parallel to the sea shore; sandy; without trees. High humidity (75-76% in Mazatlán and Veracruz). Mean temperature 24°-25°C. Subdivided in: Station of dunes and reefs, with abundant *Gramineae: Ipomoea pes-caprae* L.; bushes of *Chrysobalanus icaco* L.; *Desmodium; Acacia cornigera* Willd.; extensively developed cocoanut palms, *Orbignya, Scheelea, Acrocomia*, etc.

Station of intermediate lakes and marshes, with *Riccia* among the *Bryophytes* and *Azolla* and *Salvinia* in the *Pteridophytes; Pistia; Hydrocharis; Lemna;* several *Potamogetonaceae* associated with *Najas* and *Myriophyllum; Characeae* of the genera *Chara* and *Nitella; Utricularia; Crantzia;* and others.

Inland prairie station, with *Guazuma; Cordia boissieri* DC.; *Ceiba aesculifolia* (H.B.K.) Br. et Baker; several species of *Ficus*. In the river mouths, *Rhizophora mangle, Conocarpus erecta, Guarea,* and *Combretum farinosum* H.B.K. are abundant.

II. *Tropical Region*:- Slightly more humid in the Gulf Coast than in the Pacific, it varies in elevation from 150 m. on the East coast and 400 m. in the W. to about 1000 m.; these limits being narrower as it advances to the North, extending horizontally into the ravines or barrancas to form the sub-region "Monte Mojino" which will be detailed later. Typical of this tropical region is the coast of Tabasco competently studied by Rovirosa.

In fresh waters: *Pistia stratiotes* L.; *Jussieua natans* Humb. & Bonpl.; *Hydrocotyle umbellata* L.; *Neptunia oleracea* Lour.; *Salvinia auriculata* Aubl.; *Wolffia columbiana* Karst.; and *Azolla caroliniana* Willd., on the surface; and *Cabomba aquatica* Aubl.; *Ceratophyllum demersum* L. and *Vallisneria spiralis* L., more or less submerged.

We find, fixed in the mud, *Typha angustifolia* L.; *Wedelia paludosa* DC.; *Sagittaria sagittifolia* L.; *Acnida cannabina* L.; *Thalia geniculata* L. always associated with *Cephalanthus occidentalis* L. The paraclimatic formations are made up mainly of *Coffea arabica* L.; *Vanilla fragrans* (Salisb.) Ames; *Mangifera indica* L.; *Nicotiana tabacum* L.; *Ananas sativus* Schult.; many species of the genus *Musa; Theobroma cacao* L.; *Manihot esculenta* Crantz; and *Dioscorea alata* L.

*Gramineae* are represented chiefly by *Bambusa; Phragmites communis* Trin.; *Olyra latifolia* L.; *Arundo donax* L. and *Gynerium sagittatum* (Aubl.) Beauv. In the paraclimatic zone, *Saccharum officinarum* L.; *Oryza sativa* L. growing among

*Translated by Prof. F. P. Villagrán, M.Sc. — A somewhat accurate vegetation map of Mexico cannot be easily made, especially not on a small scale, as most of the territory of Mexico is so mountainous and uneven that species of a very different character may be found quite close together. In the Valley of Mexico there is a zone to the North with *Cacti, Agaves, Fouquieria, Yuccas* and other desert plants, while to the South there are lakes with a profusion of aquatic life. The valley is surrounded by mountains 3,000 to 5,000 meters high where *Coniferae* abound. It is the same in many other regions, especially in Central and Southern Mexico where tropical regions border on alpine regions. A "preliminary vegetation map", a map of the natural regions of Mexico, and other material of interest to botanists may be found in E. M. Sanders 1921, The Natural Regions of Mexico (Geogr. Rev. 11:212-242.)

*Cyperaceae* like *Eleocharis chaetaria* Roem. & Schult.; *Fuirena umbellata* Rottb.; *Cyperus*, and others.

The more important *Cactaceae* are *Opuntia dillenii* (Ker-Gawler) Haworth; *Selenicereus hamatus* (Scheid.) Britt. & Rose; *Hylocereus undatus* (Haworth) Britt. & Rose; *Rhipsalis cassytha* Gaertner; *R. purpusi* Weingart; *Cephalocereus sartorianus* Rose; *Epiphyllum oxypetalum* (DC.) Haworth; *E. anguliger* (Lemaire) Don.; *Phyllocactus; Heliocereus; Nopalea; Pereskiopsis; Pereskia; Nopalxochia;* many *Bromeliaceae* and numerous epiphytic *Orchidaceae.*

Among the more typical *Filicinae* of the lagoons and marshes of Tabasco *Polypodium tetragonum* Swartz; *Acrostichum aureum* L.; *Blechnum serrulatum* Rich.; *Nephrodium unitum* R. Br. and *Ceratopteris thalictroides* Brongn. must be cited.

The "Monte Mojino"*, quite distinct from the common chaparral, forms a sub-region that extends into the ravines and canyons of the tropical region and is characterized by the typical associations that form it.

The plants are represented by vines and shrubs such as *Vitex mollis* H.B.K.; *Prestonia; Vincetoxicum lutescens* Standl.; *Paullinia; Ipomoea;* many *Bignoniaceae, Urticaceae* and *Euphorbiaceae.* The *Bromeliaceae* are abundant, and among the *Cactaceae* the genera *Nopalea, Acanthocereus, Myrtillocactus, Pachycereus, Lemairocereus* and *Cephalocereus* are represented by many species; as epiphytes *Deamia testudo* Karw.; *Rhipsalis cassytha* Gaertner and some species of *Phyllocactus* are particularly conspicuous.

In addition, *Schrankia aculeata* Willd.; *Pisonia hirsuta* Choisy and numerous speceis of *Byrsonima*, are typical. *Ceiba aesculifolia* (H.B.K.) Br. et Baker is predominant in the West and *Ceiba pentandra* (L.) Gaertn. in the East.

III. *Subtropical Region*:- Limited below by the regions previously mentioned, it extends vertically, with some interruptions for about 1500 m. into the humid ravines of the Mexican High Plateau, with a very similar flora on the eastern and western slopes. In the lower parts, *Gramineae* and small forms of *Quercus* are abundant; the *Coniferae* begin at 1250 m. and extend upward, increasing in number from 1800 to 2200 m. above sea level. Typical *Filicinae* of this region are *Gleichenia; Blechnum; Polypodium; Lygodium; Adiantopsis; Adiantum; Dryopteris; Selaginella;* and the arborescent genera *Balantium, Cyathea, Alsophila* and *Leptochilus.* Of other groups we find *Ipomoea, Tibouchina, Heterocentron, Arthrostema, Monochaetum, Conostegia, Clidemia, Miconia* and many species of *Senecio* associated with them.

The principal genera of *Gramineae* are *Tripsacum, Saccharum, Chrysopogon, Arundinella, Panicum, Muehlenbergia, Poa* and *Isachne.* Among the *Cyperaceae Dichromena, Scleria, Rhynchospora* and *Carex* are conspicuous. In the *Cactaceae* we find *Rhipsalis, Selenicereus, Acanthocereus, Deamia, Hylocereus, Pereskia* and *Nopalea* as the predominant genera.

In other groups there are to be found *Yucca aloifolia* L.; *Acronomia; Chamaedorea;* numerous species of *Quercus*: *Q. sartorii* Liebm.; *Q. insignis* Mart. & Gal.; *Q. polymorpha; Q. xalapensis*, etc.; also many species of *Pinus*: *P. montezumae* Lamb., *P. patula* Schl. & Cham., *P. teocote* Schl. & Cham., *P. leiophylla* Schl. & Cham., *P. lawsoni* Roezl. *Liquidambar styraciflua* L.; *Croton gossypiifolius* Vahl.; *Acacia cornigera* (L.) Willd. and *Ipomoea arborescens* (Humb. & Bonpl.) Don are also typical of this region.

The most common genera of *Orchidaceae* found are *Pelexia, Physosiphon, Isochilus, Epidendrum, Laelia, Lycaste, Maxillaria, Stanhopea, Ornithocephalus, Galioglossum* and *Dichaea;* and among the *Bromeliaceae*: *Aechmea, Pitcairnia, Tillandsia;* in other groups: *Loranthus, Phoradendron* and *Cuscuta.*

IV. The *Desert Regions*, characterized by their very peculiar associations, can be divided in:

1. Arid sub-regions:
   a) of the N. of Sinaloa and W. of Sonora,
   b) of Lower California.
2. Texan-Mexican sub-region of the N.
3. Southern sub-region.

1a) The *arid sub-region of the N. of Sinaloa and W. of Sonora* presents the following typical associations: The predominating herbaceous plants are *Astragalus mollissimus* Torr., *A. caryocarpus* Ker-Gawl.; *Asclepias latifolia* Rafin.; *A. tuberosa* L.; *Hoffmanseggia jamesii* Torr. & Gray and *Psoralea.* The *Gramineae* are represented by the genera *Sporobolus, Eleusine, Panicum, Paspalum*, etc. In the *Cactaceae, Opuntia cholla* Weber; *O. thurberi* Engelm.; *Ferocactus wislizeni* (Engelm.) Britt. & Rose; *Lemairocereus thurberi* (Engelm.) Britt. & Rose and *Lophocereus schottii* (Engelm.) Britt. & Rose, are the most abundant.

In other groups there are the widely distributed species: *Agave lecheguilla* Torr.; *Pithecollobium tortum* Mart.; *Jatropha spathulata* (Ort.) Muell.; *Fouquieria splendens* Engelm.; *F. peninsularis* Nash; *Acacia farnesiana* (L.) Willd.; *Haematoxylon brasiletto* Karst.; *Elaphrium laxiflorum* (Wats.) Rose; *E. microphyllum* (A. Gray) Rose; and *Ipomoea arborescens* (Humb. & Bonpl.) Don. The "chaparral" is formed mainly by many species of *Scrophulariaceae, Urticaceae* and *Mimosaceae.* The large species of trees are *Prosopis cinerascens* A. Gray; *Guaiacum coulteri* A. Gray; *Randia thurberi* S. Wats.; *Bumelia occidentalis* Hemsl., and *Acacia occidentalis* Rose.

(1b) The *desert sub-region of Lower California* could be included, geographically, in the sub-region just studied but has a peculiar type of associations which make it different. Its flora starts with *Roccella*, a lichen. The principal herbaceous species are *Abronia gracilis* Benth.; *Euphorbiaceae* of the genera *Acalypha, Jatropha, Pedilanthus* and *Euphorbia;* in the *Gramineae*: *Tripsacum lemmoni* Vasey, *T. dactyloides*

**Mojino*, corruption of the Spanish word "mohino" which means "sad".

L.; *Chrysopogon nutans* Benth.; *Manisuris granularis* L.; *Hilaria rigida* Vasey; *Cenchrus myosuroides* H.B.K.; *Panicum sanguinale* L. etc.—*Dudleya anthonyi* Rose; *Mesembryanthemum crystallinum* L.; numerous *Ferocacti* like *F. wislizeni* (Engelm.) Britt. & Rose, *F. fordii* (Orcutt) Britt. & Rose, *F. viscainensis* H. E. Gates, and *F. diguetti* (Weber) Britt. & Rose, one of the largest known, are common. Other typical *Cactaceae* are *Machaerocereus gummosus* (Engelm.) Britt. & Rose, *M. eruca* (T. S. Brandeg.) Britt. & Rose; *Lophocereus schottii* (Engelm.) Britt. & Rose, of great size; many *Lemairocerei;* in the genus *Agave*: *A. nelsoni* Trel., *A. pringlei* Engelm., *A. promontorii* Trel., *A. vexans* Trel. and associated with them *Idria columnaris* Kellogg, extraordinarily developed, which is one of the more characteristic plants of this region; also *Chenopodiaceae* of the genus *Atriplex,* including *A. canescens* (Pursh) Nutt., *A. linearis* Wats. and *A. barclayana* D. Dietr.; *Amaranthaceae* of the genera *Celosia* and *Dicraurus* and the very common *Capparidaceae Atamisquea emarginata* Miers. Of other groups: *Pithecollobium flexicaule* (Benth.) Coulter; *Acacia filicoides* (Cav.) Trel.; *A. greggii* A. Gray and *Fouquieria peninsularis* Nash are to be found. The palms and Yuccas are represented by *Cocos nucifera* L. and *Phoenix dactylifera* L., both cultivated; many *Washingtonia* and *Erythea; Yucca valida* T. S. Brandeg., *Y. whipplei* Torr. and at least three species of *Nolina.* The predominant trees are *Forchhammeria watsoni* Rose; *Albizzia occidentalis* T. S. Brandeg.; *Prosopis juliflora glandulosa* (Torr.) Cockerell and *P. juliflora velutina* (Wooton) Sarg.; *Pithecollobium dulce* (Roxb.) Benth.; *P. tortum* Mart.; *Acacia farnesiana* (L.) Willd. widely distributed; *Cercidium, Haematoxylon brassiletto* Karst.; *Simondsia californica* Nutt.; numerous *Burseraceae* with the genus *Elaphrium* as predominant and *Anacardiaceae* such as the remarkable *Pachycormus discolor* (Benth.) Coville.

(2) The *Texan-Mexican sub-region of the N.* is the largest of the desertic regions of Mexico, limited to the S. by the mountains of Zacatecas, to the S.E. by the Sierra de San Luis and to the S.W. by the Sierra de la Breña, it extends to the N. into the states of Texas, Arizona and New Mexico in U.S.A. In its Mexican portion, two zones may be distinguished: to the E. the great Valle del Salado and the Bolsón de Mapimí to the W. Rain is notably scarce and changes in temperature are wide and sudden (from 40°C. to 0°C. or less). Strong winds which blow great clouds of dust are not infrequent. All these conditions determine important adaptations in the plants of this region. Its flora may be summarized as follows: intermediate between the woody and herbaceous plants are to be noted *Crotalaria;* many species of *Dalea; Indigofera sphaerocarpa* A. Gray; *Astragalus, Zornia* and numerous species of *Desmodium; Sophora* and many *Hoffmanseggiae.* — Cotton is cultivated in large zones of this region. — The *Gramineae* are represented by the genera *Paspalum, Panicum, Setaria, Cenchrus* and *Andropogon,* principally. Many *Yuccas* are to be found: *Y. rigida* Trel., *Y. treculeana* Carr., *Y. australis* (Engel.) Trel., and with them *Samuela carnerosana* Trel. and *Dasylirion durangense* Trel. are common. The genus *Agave* is represented by many species, namely: *A. lecheguilla* Torr., *A. asperrima* Jacobi, *A. falcata* Engel., *A. parrasana* Berger, *A. scabra* Salm-Dyck, *A. weberi* Cels., *A. chihuahuana* Trel., *A. parryi* Engel., *A. crassispina* Trel., *A. eduardi* Trel., *A. felina* Trel., *A. patonii* Trel. and *A. bracteosa* Wats.

The more common *Cactaceae* are: *Opuntia macrocentra* Engel., *O. durangensis* Britt. & Rose, *O. leucotricha* DC., *O. imbricata* (Haw.) DC., *O. leptocaulis* DC., *O. bulbispina* Engel., *O. azurea* Rose, *O. kleiniae* DC.; *Grusonia bradtiana* (Coulter) Britt. & Rose; *Peniocereus greggi* (Engel.) Britt. & Rose; *Mammillaria microcarpa* Engel. and *M. mercadensis* Patoni; *Coryphanta muehlenpfordtii* (Poselger) Britt. & Rose, *C. neomexicana* (Engel.) Britt. & Rose and *C. cornifera* (DC.) Lem.; *Echinocereus dasyacanthus* Engel., *E. conglomeratus* Forster, *E. subinermis* Salm-Dyck, *E. delaetii* Gürke, *E. longisetus* (Engel.) Rümpler; *Ferocactus wislizeni* (Engel.) Britt. & Rose, *F. latispinus* (Haw.) Britt. & Rose; *Escobaria chihuahuensis* Britt. & Rose; *Mammillopsis senilis* (Lodd.) Weber; *Roseocactus fissuratus* (Engel.) Berger; *Ariocarpus retusus* Scheid.; *Astrophytum myriostigma* Lem.; *Echinocactus horizonthalonius* Lem.; *Stenocactus multicostatus* Berger; *Homalocephala texensis* (Hopff.) Britt. & Rose.

In this desert region, the shrubby species are naturally much less developed, such as *Covillea tridentata* (DC.) Vail and *Fouquieria splendens* Engelm., which are quite typical, with many *Cassia, Cercidium floridum* Benth. and *Koeberlinia spinosa* Zucc., *Mimosa pigra* L.; several species of *Acacia; Pithecollobium brevifolium* Benth., *Prosopis juliflora* DC., *Parthenium,* etc.

(3) The *Southern sub-region* is located between 16° and 20° N. and is generally very dry with scanty rain which falls in form of brief heavy showers, immediately absorbed by the calcareous rocks forming its main substratum; it has a mean temperature of 20°C. The fossils found reveal the previous existence of a vegetation quite different from the one which now exists. This is characterized by the great abundance of *Cactaceae,* grouped in typical form, among which may be mentioned *Opuntia hoffmanni* Bravo, *O. depressa* Rose, *O. ficus-indica* (L.) Miller and *O. atropes* Rose; *Cephalocereus hoppenstedtii* (Weber) Schum., very abundant, *C. macrocephalus* Weber and *C. tetetzo* (Weber) H. Bravo H. with edible flowers and fruits; *Escontria chiotilla* (Weber) Britt. & Rose; *Pachycereus marginatus* (DC.) Britt. & Rose; *Lemairocereus weberi* (Coulter) Britt. & Rose, *L. hollianus* (Weber) Britt. & Rose, *L. chende* (Goss.) Britt. & Rose; many *Wil-*

*coxia, Myrtillocactus, Ferocactus* and *Echinocactus*. A remarkable place in this region is the "Cañon del Zopilote" in which *Opuntia velutina* Weber, *Cephalocereus mezcalaensis* H. Bravo H., *Lemairocereus pruinosus* (Otto) Britt. & Rose; various *Myrtillocactus* and *Mammillaria* are the outstanding Cacti. The more characteristic *Agaves* of this sub-region are: *Agave stricta* Salm-Dyck, *A. roezliana* Baker, *A. verschaffeltii* Lem., *A. potatorum* Zucc., *A. mitraeformis* Jacobi, *A. macroacantha* Zucc., *A. karwinskii* Zucc., *A. triangularis* Jacobi and *A. rubescens* Salm-Dyck, to which may be added *Hechtia rosea* Morren and *H. tehuacana* Robinson, also frequent.

*Pedilanthus* and *Euphorbia* of the *Euphorbiaceae* and *Fouquieria formosa* H.B.K. of the *Fouquieriaceae*. — *Yucca periculosa* Baker; *Nolina longifolia* Hemsl., *N. parviflora* Hemsl.; *Beaucarnea stricta* Lem., *B. gracilis* Lem. and *Dasylirion lucidum* Rose are also abundant.

The outstanding trees are *Ipomoea arborescens* (Humb. & Bonpl.) Don with large water reserves; *Cordia boissieri* DC.; *Ceiba pentandra* (L.) Gaertn.; *Crescentia, Parosela, Cassia, Goldmania; Acacia hindsii* Benth.; *A. farnesiana* (L.) Willd. and *Prosopis juliflora* (Sw.) DC.

On these arboreous forms are found *Cissus*, many species of *Tillandsia, Cuscuta, Clematis* and *Loranthus*.

V. *Region of the Central Plateau*, divided in two non-continuous sub-regions with characters different from the Southern Desert sub-region and from the "Monte Mojino" of the Tropical Region.

(1) The *temperate and dry sub-region of the Southern Plains* comprises the valleys of Mexico, Toluca, Puebla, Morelia and Tlaxcala and large portions of the plains in the States of Querétaro, Aguascalientes, Guanajuato and southern part of San Luis Potosí, where plants have to bear extreme dry heat in summer, severe cold in winter, intense evaporation, strong winds and great scarcity of water.

The vegetation of these plains belongs mainly to *Gramineae, Liliaceae, Amaryllidaceae, Leguminosae, Cactaceae* and *Compositae*. Typical of each group are:

*Gramineae*: *Euchlaena* and *Tripsacum*, so important in the study of the origin of Corn; *Andropogon saccharoides* Sw., *A. macrourus* Michz.; *Aegopogon cenchroides* H.B.K.; *Hilaria cenchroides* H.B.K.; *Cenchrus tribuloides* L.; *Setaria glauca* Beauv. and *S. viridis* Beauv.; *Paspalum distichum* L.; *Panicum crus-galli* L., *P. bulbosum* H. B.K., *P. prolificum* Lam.; *Aristida; Stipa; Muehlenbergia; Sporobolus; Polypogon; Epicampes; Agrostis; Avena; Buchloe; Cynodon dactylon* Pers.; many *Bouteloua, Diplachne, Eragrostis, Distichlis prostrata* Desv. and *D. spicata* L. Green, important as fixers of moving sands in the upper valleys. The principal cultivated genera are *Zea, Triticum, Lolium, Hordeum, Phalaris* and *Arundo*. There are also many *Cyperaceae* which grow freely in all damp places, specially *Cyperus bourgaei* Clarke and *C. seslerioides* H.B.K.

Of the *Liliaceae* and *Amaryllidaceae* the following genera may be cited: *Nolina, Beaucarnea* and *Yucca*, including *Y. aloifolia*, L., *Y. treculeana* Carr. and *Y. australis* (Engel.) Trel. in the first family, and in the second: *Fourcroya roeglii* and *F. bedinghausi* and numerous species of *Agave*: *A. americana* L., *A. filifera* Salm-Dyck, *A. yuccaefolia* DC., *A. xylonacantha* Salm-Dyck, *A. striata* Zucc., *A. attenuata* Salm-Dyck as wild, and as cultivated species *A. atrovirens* Karw., *A. salmiana* Otto, *A. cochlearis* Jacobi and *A. lehmanni* Jacobi.

The *Leguminosae* are represented by *Crotalaria pumila* Ort.; many species of *Lupinus; Melilotus indica* Alt.; *Trifolium amabile* H.B.K. and *T. involucratum* Ort.; *Indigofera suffruticosa* Mill.; *Dalea citriodora* Willd. and *Calliandra grandiflora* Benth.

Among the *Cactaceae* we find great variety of species of *Opuntia, Pachycereus* and *Mammillaria*.

The most typical *Compositae* are *Vernonia; Baccharis conferta* H.B.K.; *Ageratum corymbosum* Zucc.; *Stevia clinopodia* DC.; *Eupatorium; Coleosanthus pendulus* (Schrad.) Kuntze, *C. veronicaefolius* (H. B.K.) Kuntze; *Selloa glutinosa* Spreng.; *Aplopappus venetus* (H.B.K.); *Aster; Erigeron; Gnaphalium; Ambrosia; Xanthium; Zinnia; Aganippea; Sanvitalia; Parthenium; Tithonia; Bidens; Cosmos; Helenium; Poraphyllum; Tagetes; Artemisia; Senecio; Circium; Perezia; Eupatorium*, etc.

The most important arboreal forms are *Schinus molle* L., *Buddleia americana* L. and many species of *Acacia*.

(2) *Hot sub-region of the South of the "Mesa Central"*, also non-continuous, would correspond partially to the C A′ division in Köppen and Thornthwaite's: classification, extending somewhat to the W.

The more abundant species are: *Milla, Spigelia longiflora;* many *Urticaceae; Bromus, Paspalum, Andropogon, Stipa, Agrostis;* of the *Cactaceae*: *Opuntia atropes* Rose and many species of *Lemairocereus, Pachycereus* and *Mammillaria; Acacia farnesiana* L.; *Thevetia thevetioides* H.B.K.; resinous *Elaphrium*. The principal arboreal species are *Leucopremna mexicana* A. DC., *Enterolobium cyclocarpum* (Jacq.) Griseb., and especially *Ficus*, which has in this region a center of dispersion.

The most important cultivated species are: *Pachyrhizus angulatus* Rich.; *Cucumis melo* L.; *Citrullus vulgaris* Schrad.; *Ipomoea batatas* L.; *Spondias;* all cultivated *Citrus; Calocarpum mammosum; Achras zapota* L.; *Persea americana* Mill. and *Psidium guajava* L.

VI. *Region of the "Sierra Madre"*:- Located between 2200 and 3200 m. above sea level in the mountains, it is really the forest region. Its most distinctive feature are its groups of *Pinus* formed mainly by *Pinus arizonica* Engelm., *P. ayacahuite* K. Ehrenb., *P. hartwegii* Lindl., which reach the highest parts, and *P. cembroides* Zucc., *P. lumholtzii, P. rudis* Endl., *P. pseudostrobus*

Lind., *P. teocote* Schl. & Cham. and *P. montezumae* Lamb. on lower levels. Associated with these *Pini* is *Quercus*, in such a variety of species, that, according to STANDLEY, they number nearly 200.

VII. *Cold, Slightly Humid Region of the Top of the High Mountains*:- With a lower limit of 3200 m. above sea level, it extends vertically to 4800 m. where the last *Lichenes* are found ("Head" of Mt. Iztaccihuatl). The upper limit of the *Pinaceae* is given at 3850 m. by Dr. ATL and at 4000 m. by C. A. PURPUS, although *Juniperus tetragona* Schl. may reach 4400 m. as an extreme representative of the principal species of trees.

The highest associations are often formed by many *Gramineae*: *Sporobolus, Trisetum, Festuca* and delicate *Muehlenbergia* on the "Pico de Orizaba" and other peaks. Other typical groupings at slightly lower levels are formed by *Senecio calcarius* H.B.K., *Lupinus elegans* H.B.K., *Arenaria bryoides* Willd. and *Draba pringlei* Rose.

The preceding lines should be considered only as a very brief outline of the geographic distribution of plants in Mexico. The large area of the country, its high mountains, deep ravines and different conditions of humidity make possible the life of a great variety of plants, to such an extent that one of the most famous explorers of all times, Baron ALEXANDER VON HUMBOLDT, who traveled widely over Mexico, expressed the opinion that *its vegetation can well be considered as a synthetical representation of that of the whole world.*

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*Some of the most important references about plant distribution in Mexico:-* Anales del Instituto de Biologia, Vols. I to XII (1930/1941). — BARROSO, AGUSTIN, La Vegetación del Istmo de Tehuantepec, 1874. — BRAVO H., HELIA. Las Cactáceas de México, 1937. — Contributions from the U.S. National Herbarium. — CONZATTI, C., Los Géneros Vegetales Mexicanos, 1903. — MARTINEZ, MAXIMINO, Plantas Utiles de la República Mexicana, Méx. 1937. — MOCIÑO y SESSE, Plantas de Nueva España, 1893. — RAMIREZ, JOSE Dr., La Vegetación de México, 1899. — ROVIROSA, JOSE N., Several papers published in "La Naturaleza". — STANDLEY, PAUL C., Trees and Shrubs of Mexico, 1920-1926. — URBINA, MANUEL C., Catálogo de Plantas Mexicanas, 1897.

H. ARTHUR MEYER: Forestry in Mexico:- *I. History of the Mexican Forestry Movement.* Not until the beginning of this century did influential citizens of Mexico and representatives of the Government take active steps to protect the Mexican forests from unnecessary and ruthless destruction. It is true that long before many farsighted men had warned the people of the consequences of forest devastation, and often large forest fires drew the attention of the public to this important problem. But such warnings were not heeded or followed by protective measures. While the Mexican Congress concerned itself from time to time with various forest problems, the legislators were unwilling to enact any drastic legislation which would favor the Mexican forest. The governments of the various states were likewise unable to promote laws to conserve the forests of the mountainous regions of the country, because such laws would naturally conflict with the immediate interests of the local communities and the large landowners. Local cutting restrictions and other decrees which were actually in force under the Spanish rule, that is to say before 1810, were discarded after the liberation, but not replaced by new ordinances. The National Government did not dare to restrict by federal legislation the sovereignty of the states. Under these unfortunate circumstances the destruction of the forests by the indigenous population, in progress for centuries, was allowed to continue and even to increase as the lumber men invaded the virgin Sierras of the north and the forested areas in the vicinity of the larger centers of population.

It is an established fact that most of the denuded and badly eroded mountains and hills, so familiar to the visitor of the many famous archaeological sites throughout the country, were once covered with forests. The gradual destruction of the Mexican soil by erosion, which took place after the destruction of the original forests, is paralleled on the same scale only in the countries around the Mediterranean basin and in China.

With these few historical facts in mind, it is easy to understand that the forest conditions in Mexico at the end of the nineteenth century must have been of deep concern to many patriotic citizens of Mexico. The man who actually initiated a campaign in favor of the Mexican forest was Ing. MIGUEL ANGEL DE QUEVEDO, a civil engineer by profession, known as the father of Mexican Forestry. He was born in Guadalajara, the capital of the state of Jalisco, and studied at the Ecole Polytechnique in Paris. Back in his native country working on hydraulic power projects, Ing. DE QUEVEDO came in close contact with the Mexican forest problem. His thorough knowledge of his profession enabled him to recognize the importance of the forest for the protection of watersheds. He was alarmed by the rapidly advancing devastation which occurred along the railway leading from Mexico City to the industrial town of Orizaba and to the port of Veracruz. In the ensuing years he devoted more and more of his time to conservation and forestry. Entrusted with the reconstruction of the port of Veracruz, he carried out a large scale reforestation program in order to consolidate the shifting sand dunes which represented a serious menace to the port and the town itself. At that time the situation was so serious that plans were being made to establish a new harbor 120 miles to the south, which would have lengthened by that distance the railroad from the Gulf of Mexico to the capital of the country. For obvious reasons this project was favored by the railroad company. The reforestation, however, which followed the pattern of the work done in France, was a complete success.

In 1901, at the Second Meteorological Congress in Mexico, Mr. DE QUEVEDO brought the forestry problem of his country for the first time before a large public audience. In 1904 he finally succeeded in establishing a central forestry committee within the Department of Agriculture. Thus the official forestry movement in Mexico came only a few years after the nomination of the first Chief Forester of the United States.

The members of the Central Committee began their activities with the improvement of the public parks of the city of Mexico, and with an investigation of the forests in the vicinity of the capital. A large forest nursery was soon established in Coyoacán (a suburb of Mexico City) the ancient residence of HERNANDO CORTÉZ. Some difficulties arose in the coming years because of changes in the ministry of agriculture, and not until 1907 could the committee promote more fruitful activity. In this year Mr. DE QUEVEDO went abroad to study the forest conditions in France, Spain, Germany, Switzerland and other countries. Later a number of French foresters were called to Mexico to cooperate with the Central Committee. A forest ranger school was then established in Coyoacán. The students received a year's training, while being held under military discipline. With some interruptions, this school was later continued at various other places.

The history of the gradual evolution of the Mexican forest service up to the present time is briefly as follows: In 1909 the Central Forestry Committee was dissolved by a decree of President PORFÍRIO DÍAZ. In its place a Bureau of Forestry was established within the Department of Agriculture. Under the direction of Ing. DE QUEVEDO this new office did not begin to function until July 1, 1910. A short time afterwards the Mexican Revolution interrupted and restricted all forestry activities in Mexico for many years. It was not until 1934 that a reorganization of the forest service occurred. This came about under the leadership of the former President LÁZARO CÁRDENAS, and the forest service was then given the status of an autonomous department within the executive branch of the federal government. President CÁRDENAS, who was especially impressed by the excellent work accomplished at the port of Veracruz, again entrusted Ing. DE QUEVEDO with the direction of the new "Departamento Forestal y de Caza y Pesca" (Department of Forestry, Game and Fish). Thus the life work of the untiring "apóstol del árbol" received its highest possible recognition.

Very recently the forest service was placed back under the Department of Agriculture.

*II. Area, Distribution and Types of Forests.* Although there is considerable known about type and composition of a great number of Mexican forests, it is still rather difficult to give a complete picture of the existing forest types and their distribution. The varied topography and the great differences in elevation result in a corresponding difference in climatic conditions and hence types of vegetation. Tropical forests cover the coastal regions on the gulf of Mexico and a narrow strip along the pacific coast. Embedded between the western mountain range of the Sierra Madre and the mountains in the East near the Gulf Coast lies the vast tableland of Mexico with an altitude of from 5000 to 8000 feet above sea level. A sub-tropical vegetation covers the foot hills of the main mountain ranges, which unite in the southern part of the country. Coniferous forests of great commercial importance cover the mountains of the Sierras. Large areas in the west, the central and the northern part of the tableland are extremely dry, supporting only a scarce vegetation of Mesquite, *Cactus* and *Agave.*

Botanically, the existing trees and shrubs of Mexico are rather well known. They are described by PAUL C. STANDLEY in five volumes, published by the Smithsonian Institution in Washington. Yet, the practicing forester may still find himself in great difficulties in trying to determine the scientific name of an important forest tree found in remote regions of the country. There is no doubt but that a great deal of botanical research remains to be done, especially in tropical forests, before all the existing timber trees of Mexico are adequately described.

At the present time less is known of the existing forest types. In the files of the Mexican forest service there are a great many valuable reports on specific forest areas of the country. Many of these reports have also been published in official bulletins. However, up to the present time no one has compiled and made this information available in a comprehensive study covering every region of the country. An attempt to outline and to map the major forest regions or "zones" of Mexico was made in 1937 by JOSÉ GARCÍA MARTÍNEZ, who at that time was chief of the statistical office of the Department of Forestry, Game and Fish. The forest zones established by MARTÍNEZ are chiefly based on the topographical features of the country. The resulting map, which is reproduced in Figure 1, gives quite a satisfactory picture of the distribution of the major forest zones, since the forest type is intimately correlated with altitude. It would take too much space to give a description of each of these major zones and of the prevailing climates and subsequent types of vegetation. Some pertinent data have been assembled in Table 1, showing the total extension of various zones of altitude and the estimated forested area within each of these zones.

According to this table only 28.5 million hectares[1] or 14.5 per cent of the total land area of Mexico is covered by forest vegetation. The estimates of the percentage of forested areas within each zone of altitude

probably refer merely to the areas actually covered by forests and do not include arid lands sustaining only a poor vegetation and which might be classified as forest land as contrasted to agricultural or tillable land. It has been estimated that of the total land area of Mexico which is 197 million hectares, only 20 million hectares are agricultural land, 30 million hectares steril land, the balance representing a type of land which could be classified as forest and range land of which only a small portion or roughly 30 million hectares is covered by high forests. A large part of the remainder is suitable to restauration and reforestation.

*Table* 1. Forested area of Mexico in different zones of altitude.

| Altitude above sea level | Total land area | | Area covered with forest vegetation | |
|---|---|---|---|---|
| meters | million hectares [1] | per cent | million hectares | per cent |
| Total | 196.9 | 100.0 | 28.5 | 14.5 |
| 0-500 | 64.7 | 32.9 | 17.0 | 8.6 |
| 500-1000 | 32.7 | 16.6 | 4.3 | 2.2 |
| 1000-1500 | 40.6 | 20.6 | 2.6 | 1.3 |
| 1500-2000 | 38.8 | 19.7 | 3.1 | 1.6 |
| 2000-2500 | 18.9 | 9.6 | 1.1 | 0.6 |
| 2500-3000 and over | 1.2 | 0.6 | 0.4 | 0.2 |

[1] One hectare = 2.47104 acres.

*III. Forest Legislation and Organization of the Mexican Forest Service.* Mexico is probably one of the first countries of the American hemisphere to enact far reaching federal forest legislation in which the public interests, which are vested in the forests of a country, are duly recognized. The "Ley Forestal de los Estados Unidos Mexicanos" is dated April 5, 1926. It was enacted during the presidency of General PLUTARCO ELIAS CALLES and is based on the famous Article 27 of the Mexican constitution of 1917, which gave the Mexican government the legal right to expropriate the foreign owned oil companies. Some of the statements made in Article 27 are of profound importance not only to Mexican forestry, but to any farsighted program of conservation in which the public good is put above the selfish interest of individuals or groups of individuals. I would like to quote the following passage from Article 27:

> "The Nation shall have at all times the right to impose on private property such limitations as the public interest may demand as well as the right to regulate the development of natural resources, which are susceptible of appropriation, in order to conserve them and equitably to distribute the public wealth. For this purpose necessary measures shall be taken to divide large landed estates; to develop small landed holdings; to establish new centers of rural population with such lands and waters as may be indispensable to them; to encourage agriculture and to prevent the destruction of natural resources, and to protect property from damage detrimental to society."

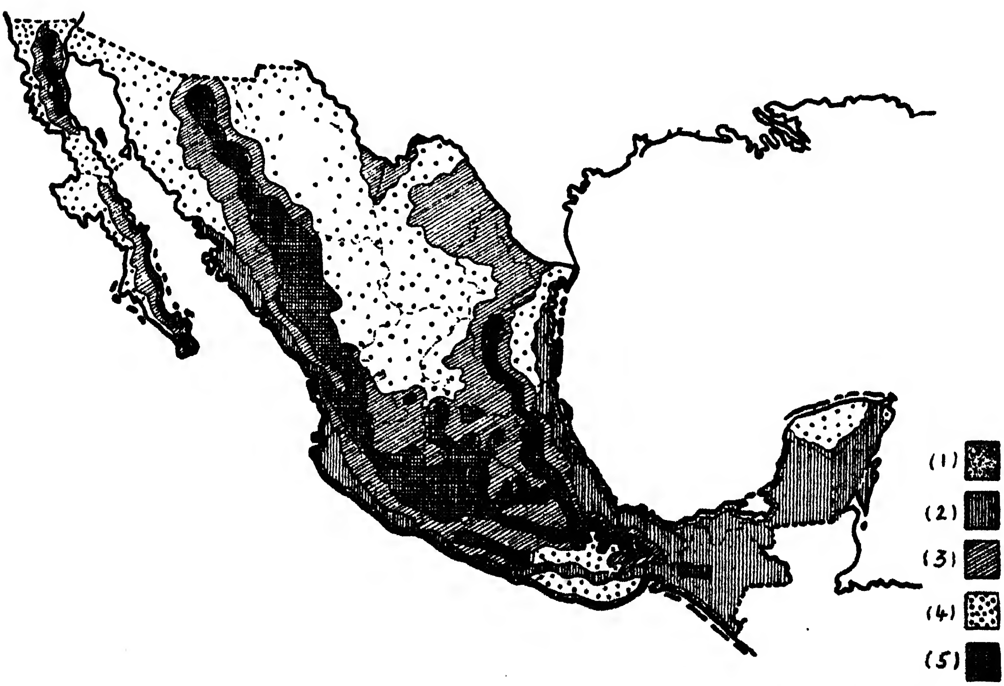


FIG. 1. — FOREST ZONES OF MEXICO. — Reproduction of map published in Boletín del Departamento Forestal y de Caza y Pesca, No. 8, 1937. — (1) Mangrove / Palms. — (2) Mahogany / Mountain mahogany / Ceiba / Chicle / Cedar (Cedrela) and many other tropical species. — (3) Oak / Copal (Elaphrium) / Piñon Pine / Senna / Alder / Arbutus. — (4) Agave / Cactus / Mesquite. — (5) Pine / White Cedar / Cypress / Fir.

This statement may truly be regarded as a cornerstone of modern social legislation. It expresses a policy upon which forest legislation of any country might be founded.

The forest law refers to all forests regardless of ownership — national, communal, corporation, and private. In rather general terms it is stated that the exploitation of the national reserves must strictly follow a previously established management plan which guarantees the sustained conservation of the forest vegetation. The exploitation of communal and corporation forests is subjected to the ordinances which shall be given by the Secretary of Agriculture. Exploitation in private forests is allowed upon special permit to be secured from the department of forestry, which shall determine the rules that must be followed.

We can hardly do more than enumerate the various matters covered by the law and to restrict a brief discussion and comments to such points as are of special interest at the present time, when public forest regulation is being considered in the United States and in other American countries where it does not already exist.

Passing over the chapters on reforestation, protection, forest diseases, forest fires, I cite Section I of Article 47, concerning forest taxation. Forest owners, subject to forest taxation "shall not pay any taxes on the value of the growing stock as long as they do not exploit it." The forest taxes as provided by a new law on forest taxation of 1936 are all yield taxes. Mexico is thus avoiding the danger of precipitating and accelerating the exploitation of forests in order to avoid the burden of a heavy property tax which, in the United States, is partly responsible for the reckless exploitation and devastation of virgin timber.

In the by-law the previously outlined prescriptions are further detailed. This by-law is especially interesting because it tells how the forest law has to be applied and enforced in practice.

The preliminaries which must be met before any permit of exploitation is granted vary somewhat for the different classes of forests and ownership and the kind of exploitation contemplated. For the exploitation of the national reserves these prescriptions are, principally, the same as those which govern the policy followed in the exploitation of the national forests of the United States.

In communal forests and Terrenos ejidales (distributed forest lands to be managed on a cooperative basis) only the removal of dead timber is allowed without a permit. The exploitation of all other products must be authorized by the Department of Forestry. Exploitation of a commercial character may be carried out only after a provisional or definite management plan, made by a technically trained forest engineer, has been established and subsequently approved by the Forest Service.

The exploitation of private forest lands is allowed only after a special permit has been obtained from the Department of Forestry and it must be carried out in accordance with well defined regulations, of which the following are mentioned. Small owners and poor people may exploit forests for domestic purposes after securing from the local forestry official a simple permit to cut branch wood in quantities not exceeding four cords a week or 192 cords a year. After a special inspection, to be made by an official of the Department of Forestry and paid for by the owner, larger quantities of wood may be cut. Large commercial forest enterprises are required to employ during the whole operation a trained forest engineer who is responsible to the government to see to it that the cutting is carried out in accordance with the provisions made in the management plan.

The most rapid and far reaching progress in the enforcement of the forest law and in Mexican forestry in general has been made under the presidency of General LÁZARO CÁRDENAS, when the branches of forestry, fish and game were administered by an autonomous department under the direction of Ing. DE QUEVEDO. The extent to which the government has actually extended its control over the exploitation of the forests is best reflected in the increasing income from forest taxation. For comparison the receipts and expenditures of the Department of Forestry, Fish and Game are shown in Table 2.

In 1940 the Mexican forest service was again placed under the jurisdiction of the Secretary of Agriculture. The official designation of the bureau is "Dirección General Forestal y de Caza." The fishery division is thus no longer jointly administered with forestry and game. Otherwise the organization of the forest service is very much the same as before. Some of the offices and sections of the newly created bureau headed by the "Director General" are: Community and "Ejidales" Forests, National and Private Forests, Nurseries and Reforestation, Forest Fire Protection, Game Management, Forest Property and Cutting Records, Legal Infringements and Fines, Control of Coöperatives, etc.

*IV. Forest Production.* Statistics on forest production are still scare and by no means all inclusive. Official statistics on wood and charcoal production are found in the September-October issue of the Boletín Forestal y de Caza, Volume 2, Number 3. According to this publication the output of wood products in the years 1933-1938 was as shown in Table 3. During the present war, production has been substantially increased in many categories.

The increase in the production of saw timber before the war is partly explained by the recent construction of highways leading through heavily forested regions. The decline in hewn timber is due to the heavier tax imposed on such timber, the

purpose of the tax being to discourage this kind of products, and to the reduced demand of railroad ties which resulted from the increased use of creosoted ties. The actual exploitation is probably larger than the amounts recorded in official statistics; still it represents only a small average exploitation per hectare. Ten million cubic meters per year would only amount to 0.35 cubic meters per hectare, while the productive capacity of the estimated forest area of 28 million hectares may be estimated to be at least 3 cubic meters per hectare. These few figures give an idea of the future potentialities of forestry in Mexico.

*Table* 3. Wood production in Mexico 1933-1938.

| | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 |
|---|---|---|---|---|---|---|
| Saw timber in 1000 cu.m. | 369 | 1419 | 585 | 600 | 648 | 477 |
| Hewn timber in 1000 cu.m. | 698 | 1817 | 387 | 369 | 317 | 399 |
| Logs in 1000 cu.m. | 136 | 880 | 199 | 61 | 66 | 250 |
| Fuelwood in 1000 cu.m. | 1447 | 2140 | 514 | 567 | 791 | 1111 |
| Charcoal in 1000 tons | 170 | 188 | 167 | 156 | 157 | 160 |

With the large number of forest types in Mexico it is not surprising that the country is producing a great variety of secondary forest products. Some of these products, if produced in greater quantities, would represent a basis for a number of important industries. At the present time the production of gum or chicle, used for the manufacture of chewing gum, is perhaps the most important one. This gum is produced by the chicozapote, *Achras sapota.* It comes from tropical forests, the principal producers being the State of Campeche and the Territory of Quintana Roo. The annual production for the entire country according to official statistics, is as follows:

1935 — 2,069,718 kgs.
1936 — 2,760,851 kgs.
1937 — 2,577,898 kgs.

Other secondary products are dyewoods, tanning materials, rubber, naval stores, coconut and palm oils.

*V. Accomplishments and Future Problems of Mexican Forestry.* In the first part of this article and in the remarks made on forest legislation and organization, many of the most important achievements of the Mexican forest service have already been mentioned. This report would not be complete, however, without mentioning some other outstanding advancements.

*Table* 2. Receipts and expenditures of the Department of Forestry, Game and Fish.

| | Income | | | |
|---|---|---|---|---|
| Year | Division of Forestry | Division of Game | Division of Fishery | Expenses |
| | Pesos | Pesos | Pesos | Pesos |
| 1929 | | 129,833 | 868,567 | |
| 1930 | | 86,775 | 823,780 | |
| 1931 | 42,792 | 56,818 | 373,429 | |
| 1932 | 49,440 | 53,782 | 575,853 | |
| 1933 | 105,390 | 59,188 | 483,625 | |
| 1934 | 153,582 | 36,828 | 431,980 | |
| 1935 | 445,496 | 41,999 | 664,002 | 2,346,533 |
| 1936 | 3,487,863 | 69,068 | 967,005 | 2,776.035 |
| 1937 | 4,764,390 | 11,709 | 1,618,552 | |

1 peso = $0.20 approximately, varying with the price of silver.

In recent years the Mexican government became fully aware of the pressing problems concerning the maintenance and conservation of the forests. The executive branch of the Government, entrusted with the conservation of these forests, has undertaken an extensive campaign in all parts of the country to impress upon the average citizen the national importance of forest conservation. One of the outstanding features of this campaign is the establishment of forest nurseries by schools throughout the country. Over 1500 such nurseries were in existence in 1938. A popular magazine "Protección a la Naturalezza" has been published and freely distributed during recent years.

A large number of beautiful natural forested areas have been set aside as National Parks. Up to 1938 twenty-five such parks had been definitely established and many more were being contemplated. The areas of these parks vary from several hundred hectares up to 70,000 hectares. A large number of tourists visit these parks each year. Most visitors of Mexico probably have seen the beautiful fir forest of the "Desierto de los Leones" near Mexico City, or the virgin oak forest in the National Park Alexander von Humboldt, located near the famous city of Tasco which itself has been declared a national monument.

In accordance with the provisions made in the forest law, a large number of forests or partly forested areas have been declared protective forest zones. These areas have been established as a protection against erosion in steep mountainous country, as a protection for watersheds and for artificial systems of irrigation. Protective zones also have been declared in the neighborhood of cities and other centers of population. Any exploitation of these forests is subject to the strictest regulations. The size of these protective zones varies greatly, ranging from about 20,000 hectares to 200,000 hectares.

Much progress has been made in forest protection, especially against forest fires. More than 10,000 farmers have been organized in "defense cooperatives" throughout the country.

The legislative background of public forest regulation has already been discussed. The enforcement of regulation in practice has been very effectively tied up with the collection of the forest yield tax. Cutting and shipping permits must be secured before any large quantity of wood may be cut and sold. The application of differential tariffs has greatly increased the radius of forest operations; the tax on wood cut near the centers of population is higher than for products coming from remote regions. In addition, high quality products are taxed higher than defective or dead wood, the removal of which is a definite advantage

to the forest. By extending the current wood operations over a larger territory, the cuttings in any particular region become less intensive. The forest tax therefore is an effective factor in helping to control forest exploitation.

The partition of the large land holdings and "haciendas" has in many ways created a new situation in regard to the administration and management of the Mexican forest. The creation of communal forests and of "Ejidales" forests has been greatly promoted in recent years. It is the opinion of leading Mexican foresters that communal forests and forest cooperatives offer the best possibilities for sustained yield management and conservative forest practices as contrasted to large scale exploitations which have been, and to a certain extent still are, carried out by large lumber companies.

The intensification and extension of forest activities throughout the country was only possible through a substantial increase in the personnel of the forest service. It was not too difficult a problem to train, in a relatively short time, a large number of forest rangers, and this has actually been done at the ranger school in Tlalpam, near Mexico City. These rangers are being placed at stations and forest delegations throughout the country. They represent a police force which sees to it that the regulations of the forest law are observed. In the enforcement of these regulations the department of forestry is assisted by the regular army.

A more difficult task at the present time is the education of technically trained forest engineers. The forest school at Coyoacán has recently been closed. It is apparent that the forest service seems to have in mind a plan to send promising young men to foreign schools where they can improve and widen their technical knowledge. Most of the well trained foresters of the country are at the present time holding important positions in the federal forest service. In due time the Mexican government will undoubtedly reestablish the school for forest engineers as well as forest experiment stations, where pressing research problems of all kinds can be solved and the results made available to the practicing forester.

The extensive organization of the Mexican forest service based on progressive forest legislation, together with the patriotic spirit of the Mexican forester, promises the most successful continuation of the forestry program which was initiated under the former President of the Republic of Mexico.

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"Revista Forestal Méxicana", 1909-1910.

"Revista Forestal de la Dirección General de Agricultura", 1911.

"México Forestal", de 1924——.

"Boletín del Departamento Forestal y de Caza y Pesca", 1935-1939.

"Boletín Forestal y de Caza", 1940——.

*A selected bibliography of articles* which have appeared in the first three of the above mentioned periodicals is contained in the Boletín del Departamento Forestal y de Caza y Pesca, No. 14, 1939, pp. 219/231.

C. L. LUNDELL: **The Vegetation and Natural Resources of British Honduras**[1]:- Although covering less than 9000 square miles, British Honduras has a diverse vegetation scarcely equaled in interest by any other Central American region. A majority of the plants of the Colony are widely distributed species of the West Indies and the Atlantic slope of Mexico and Central America, but there are many rare ones and endemics which have not been found elsewhere in North America. Except for pine, swamp, and marsh belts, the northern plain is covered with quasi-rainforest, the same type which predominates in southern Campeche, Quintana Roo, and northern Petén. The pinelands, characterized by stands of *Pinus caribaea*, have an assemblage of species similar to that of like areas in southern Florida and Cuba. The southern British Honduran rainforest, resembling in many respects that of adjacent mountainous areas of Guatemala, contains relict floral elements of relatively great age. The south-central mountain mass, continuously exposed since at least the Late Upper Carboniferous, was connected by a broad land bridge with Central America (including southern Mexico), northern South America, and the West Indies at that time, and in subsequent periods. The presence of this ancient land mass, an island in Lower Oligocene, Middle Oligocene, and in Lower Middle Miocene (after SCHUCHERT[2]), undoubtedly explains the high degree of endemism as well as the presence of genera of discontinuous distribution. Noteworthy is the occurrence of various South American species not known elsewhere on the continent. The Yucatan Peninsula as a whole, including all of British Honduras, probably has an endemic element of at least 15 per cent.

The flora, totaling possibly 4000 vascular plants, is rich considering the limited area involved. Approximately 3000 are now known; exploration of the interior highlands and intensive collecting in the marshes and pinelands should add at least another thousand species. The largest families are as follows: *Gramineae, Leguminosae, Cyperaceae, Rubiaceae, Compositae, Melasto-*

[1]Papers from the University of Michigan Herbarium.

[2]C. SCHUCHERT. Historical Geology of the Antillean-Caribbean Region. 1935. New York.

*maceae, Orchidaceae, Euphorbiaceae, Myrtaceae, Bignoniaceae, Moraceae, Acanthaceae, Solanaceae, Palmae*, and *Convolvulaceae.* From the economic standpoint, the most important families are the *Leguminosae, Meliaceae, Palmae*, and *Sapotaceae.*

The principal vegetation belts are the coastal swamp, the inland swamp and marsh, the pineland and barren, the quasi-rainforest, and the rainforest. In the coastal swamps the predominant species of the tidal flats is *Rhizophora Mangle.* Above the tidal area, the association also includes *Laguncularia racemosa, Avicennia nitida, Conocarpus erecta, Chrysobalanus Icaco, Pachira aquatica*, and *Pterocarpus officinalis. Manicaria saccifera* dominates the swampy estuary of the Temash River.

The inland swamps and marshes are diverse habitats characterized by assemblages of species depending largely upon edaphic conditions. On the northern plain, in riverain and in limestone depressions, flooded each year for considerable periods, *Haematoxylon campechianum* is the character plant. The principal marshes are either depressions in the silicious pinelands or areas of silting lagoons. In these, cyperaceous growth predominates, but colonies of *Acoelorraphe* and *Chrysobalanus* are much in evidence.

The extensive pinelands and barrens, occurring on silicious sands and coarse grits, are characterized by *Pinus caribaea*, with *Byrsonima crassifolia, Curatella americana*, and various species of *Quercus* the most evident tree associates. The herbaceous cover is largely grassy and sedgy, but numerous low perennials of other families abound. Fires sweep most of the pinelands periodically, and the stand of pine has been decimated over large sectors. In some areas only treeless barrens remain; these are often referred to as dry savannas.

The northern half of the Colony southward to the Sibun River and El Cayo has a rainfall averaging less than 65 inches annually. In this area quasi-rainforest covers outcropping limestone. The dominant tree, *Achras Zapota*, has as its chief tree associates, *Brosimum Alicastrum, Swietenia macrophylla, Cryosophila argentea, Bursera Simaruba, Protium Copal, Matayba oppositifolia, Dipholis salicifolia, Dialium guianense, Metopium Brownei, Mosquitoxylum jamaicense, Spondias Mombin, Calophyllum brasiliense*, and various species of *Lucuma, Sideroxylon, Sabal, Coccoloba, Nectandra, Ocotea, Lonchocarpus, Zanthoxylum, Trichilia, Sebastiania, Ficus*, and *Cordia.* The quasi-rainforest is not virgin, but represents an advanced secondary stage; the region it covers, as well as most of the other limestone areas of the colony, was cleared for agriculture by the ancient Maya. The forest is locally classified as either "broken ridge" or "high ridge"; throughout the Colony, these names refer to vegetation belts and have no connection with elevation. The "high ridge" is the most luxuriant phase. "Broken ridge" is an open phase usually bordering pinelands in coastal sectors. Well watered alluvial areas support dense groves of *Orbignya Cohune.*

The southern half of British Honduras has a considerably higher rainfall, averaging 170 inches at Punta Gorda, and true rainforest covers much of the area. With the greater precipitation, varied geological formations, and the mountain topography, the forests exhibit considerable diversity. The characteristic trees of the limestone areas are *Achras Zapota, A. Chicle, Sabal* spp., *Dipholis Stevensonii, Drypetes Brownii, Ilex belizensis, Terminalia obovata, Swietenia macrophylla, Pseudolmedia* spp., *Sebastiania Standleyana, Vitex Gaumeri, Sideroxylon* spp., *Trichilia* spp., *Cufodontia Lundelliana, Cymbopetalum penduliflorum, Protium* spp., *Calophyllum brasiliense, Ficus* spp., *Bourreria oxyphylla, Orbignya Cohune, Cryosophila argentea*, and *Brosimum Alicastrum.*

The rainforests of the central metamorphic region and the Toledo shales are still very little known. The principal trees are reported to be *Terminalia obovata, Calophyllum brasiliense, Symphonia globulifera, Vochysia hondurensis, Aspidosperma megalocarpon, Licania hypoleuca, Tetragastris Stevensonii*, Mountain Cabbage Palm, *Podocarpus pinetorum, Schizocardia belizensis, Ficus* spp., *Virola* spp., *Dialium guianense*, and *Dalbergia Stevensonii.* Melastomes are the most abundant shrubs.

Until 1907, when MORTON E. PECK made a collection of more than 800 numbers in British Honduras, the region was practically unknown botanically. The work of W. A. SCHIPP, one of the outstanding contributors of our knowledge of the flora, was inaugurated in 1929 and extended through 1935; his series of over a thousand numbers from the Stann Creek and Toledo Districts contained numerous new species.

The collecting in British Honduras by the writer, begun in 1928, and continued in 1929, 1933, and 1936, has resulted in the accumulation of approximately 3000 numbers of plants. In 1931, H. H. BARTLETT obtained an extensive series in the Belize tained an extensive series in the Belize and El Cayo Districts. PERCY H. GENTLE, who began his work in 1931 under the auspices of the University of Michigan, has collected continuously since that date; his excellent series now exceeds 3800 numbers. Other smaller yet noteworthy collections have been made by staff members of the Forestry Department of British Honduras, by S. J. RECORD, J. S. KARLING, WILLIAM C. MEYER, and HUGH O'NEILL. The principal collection of cryptogams was made by E. B. MAINS in 1936.

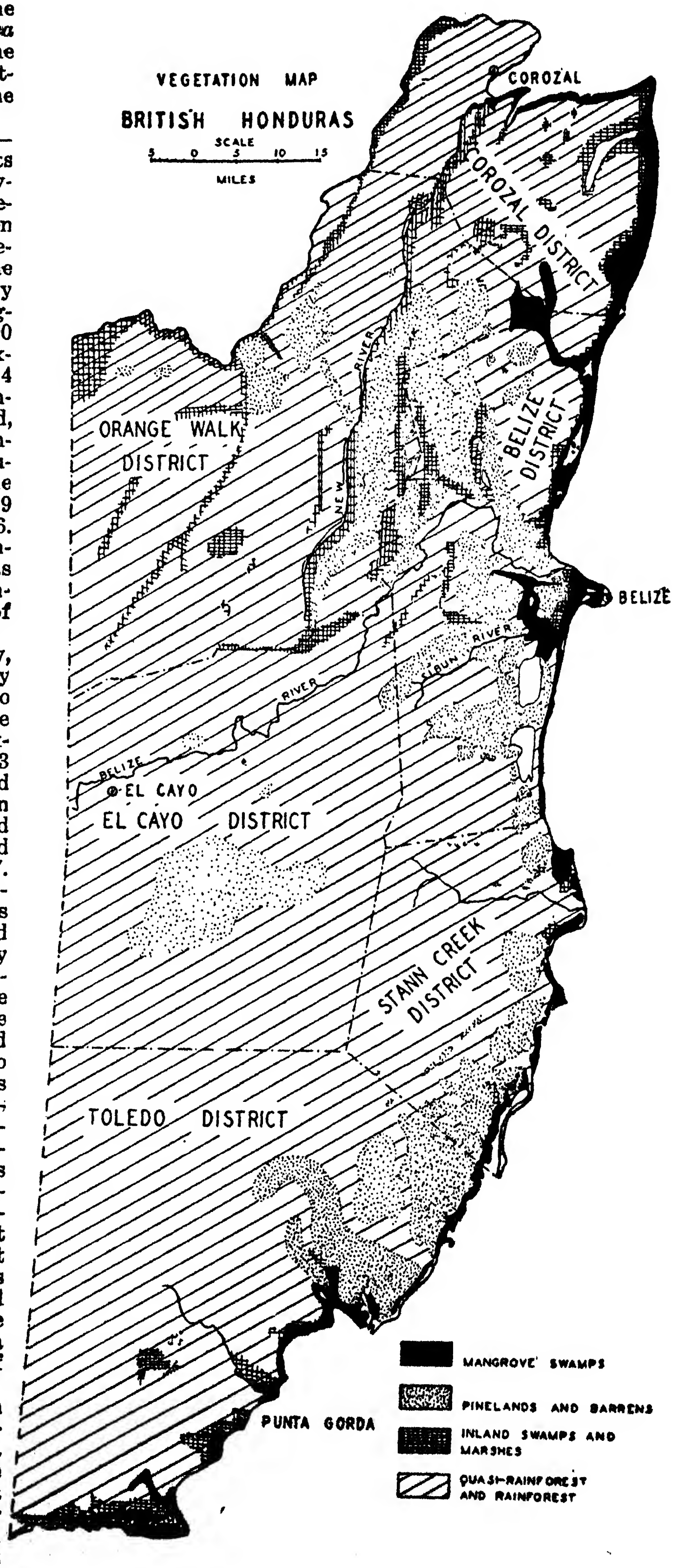
Research upon the vegetation of British Honduras has been carried out primarily by the Forestry Department of the Colony, and by the University of Michigan and the Carnegie Institution of Washington as a part of the co-operative survey of the Maya area. Based upon the accumulated collections, P. C. STANDLEY and S. J. RECORD brought out in 1936 a catalogue of the plants known from the colony up to that

time (6). The papers in the *Botany of the Maya Area* (5) series represent the only comprehensive treatments of any part of the flora.

*Natural Resources.* — British Honduras, since its first settlement in the Seventeenth Century, has depended almost entirely upon forest products for the livelihood of its people. The early history of the Colony centered around the logwood trade. In 1756, 18,000 tons of this wood was exported to England. In 1764 twenty-two vessels were engaged in carrying logwood, and 1500 cutters were employed. The trade fluctuated greatly during the Nineteenth Century; 34,539 tons were exported in 1896. Since that date, the competition of aniline dyes has brought an end to the industry; only 103 tons of logwood were cut in 1932.

The mahogany industry, still the economic mainstay of the country, began to flourish in the middle of the Eighteenth Century. Exports of the product in 1783 are stated to have reached 70,000 tons. This was in excess of the modern record of twenty-one million board feet exported in 1926-27. The mahogany trade fluctuates greatly since it depends upon the conditions of world markets. The high quality of the wood assures a continued demand. Accessible areas of the forest have been overcut ruthlessly, and the best stands are now to be found in interior sectors where operations can proceed only with costly modern equipment. With control and educational policies now carried out by the Forestry Department, the Colony can continue to export about five million board feet annually. Where seed trees are left standing, natural regeneration takes place rapidly, enough to insure a continued limited supply of mature timber.

Others woods, exported in small quantities, are Spanish cedar, banak, Santa Maria, and yemeri. The stands of pine are sufficient to meet local demands for pine lumber. With control of fires, the pine forests



could yield an excess of timber for export. The secondary woods offer possibilities for the future of the logging industry.

The third most important forest product has been chicle, the gum obtained from *Achras Zapota*. Through careless exploitation the sapodilla stand has been depleted, and the amount of gum now produced in the Colony probably is less than 300,000 pounds annually. Secondary gums from the southern rainforests may eventually prove to be of some importance.

Since the economy of the Colony has centered around its forest products, agriculture has held a very minor place. Although gardening and agriculture in general have been encouraged by every means in recent years, much food is still imported, and the country is far from self-sufficient.

Bananas, grapefruit, and coconuts are produced in exportable quantities. The ravages of the Panama disease, as well as an absence of large areas of suitable soils, have prevented the banana industry from developing on a large scale. The youthful grapefruit industry has expanded considerably, and it offers some promise for the future. Attempts have been made to grow cacao, sisal, tobacco, and sugarcane, but all have been a failure for varied reasons. The exploitation of the cohune palm nuts has met with scant success.

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WILSON POPENOE: **Plant Resources of Honduras:-** The central - and largest - part of Honduras consists of mountainous country which with the adjacent regions in Guatemala and Nicaragua forms, as one geologist puts it, "the core of Central America". Agriculturally, the republic can be divided into three zones as follows:

1. The Caribbean coastal plain, by far the most important, and in fact the only large area now producing crops for export. It is not continuous: at many points between the Guatemalan border and Cape Gracias a Dios mountains rise abruptly from the sea to heights of several thousand feet - nearly 8000 in the case of Pico Bonito, back of La Ceiba. At the northwestern corner of the republic is the extensive and fertile plain of Sula, today the most thickly inhabited and intensively cultivated area in the country. It is characterised by deep, rich alluvial soils, ranging from sandy loams (along the banks of the Ulua and Chamelicón rivers) to heavy clays. Rainfall near the coast may be as high as 150 ins. per annum, with only a short dry season in February-March. Toward the south rainfall diminishes as the mountains are approached, until in the vicinity of San Pedro Sula, metropolis of the region, it is only 40 to 60 ins., with a severe dry season, usually from January to April. Bananas are the principal crop, but cattle-raising is important, and sugar cane, corn, rice and other subsistence crops are grown more or less extensively.

2. The Sierra region is one of short mountain ranges separated in some places by canyon-like valleys, elsewhere by plains such as that of Comayagua (2000 ft. elevation) which offer rather extensive areas of agricultural land. "Much of the hill country of Honduras" write TREADWELL, HILL and BENNETT in their report on the possibilities of rubber cultivation (see below), "in the western part at least, has a thin soil, often stony, on which there are extensive forests of pine. A considerable portion of this is covered with soil which will not average two feet in depth over bedrock (mainly mica schist and light-colored volcanic rocks); often there is no soil covering at all. Upland soil conditions here are largely unsuitable for purposes other than forestry and pasturing stock". The rainfall throughout this region is irregular, probably 30 to 60 ins. per annum (few records are available); the dry season in most parts is severe. Due to the scarcity of rich soils, scanty population, and lack of good roads, agriculture has in the past been limited mainly to corn, beans, and a few other subsistence crops. In recent years, however, laudable progress has been made toward furnishing the better agricultural areas with means of communication. As a result, expansion of crop production is commencing to take place.

3. The Pacific coastal plain, a relatively small area which in an agricultural sense consists mainly of alluvial lands along the Choluteca, Nacaome and Goascorán rivers all of which empty into the Bay of Fonseca. The climate is dry and irrigation will be essential to any extensive agricultural development. The islands in the Bay of Fonseca and the mountains which rise abruptly out of the coastal plain are said by the geologist BENGTSON to be largely of volcanic origin, members of the group of volcanos which extends from Guatemala across Salvador into Nicaragua. The lack of recent volcanic activity in most other parts of the republic is in striking contrast to conditions in the three neighboring states.

This classification does not take into account the Bay Islands, which lie in the Caribbean 20 to 40 miles from the north coast. These produce coconuts and a few plantains for export, as well as subsistence crops for their own needs.

When the Spaniards colonised Honduras in the XVI century, they brought with them sugar cane, wheat, barley, citrus fruits, peaches, grapes, plantains and numerous other plants. But the presence of mineral deposits - particularly silver - plus the scarcity of good agricultural lands in the

mountainous areas where climatic conditions are salubrious, prevented the extensive agricultural development which took place in Mexico and to a somewhat less degree in Guatemala. The Caribbean coastal plain, largest area of good agricultural soils, was left practically untouched throughout the Colonial period. Even today the northeastern portion of this area has not been fully explored.

E. G. SQUIER, who made an exhaustive study of the country in the early 1850s, primarily with a view to determining the feasibility of building an interoceanic railroad, has given us an excellent account of agricultural conditions and crops at that time. Writing of Comayagua, seat of government in Colonial days, he says "The hills and mountains adjacent to the plain are covered with pines, and on their summits and slopes wheat, potatoes, and other products of the temperate zone are cultivated, and may be produced in abundance". And of the Department of Gracias, also in the highlands, "Wheat, rye, barley, the potato, etc., grow on the mountains, while sugar cane, indigo, tobacco, cotton, coffee, cacao, plantains, oranges, etc., flourish in the plains and valleys. Of valuable timber there is also great abundance." And again, of the mountains of Lepaterique, he writes that "their summits are broad, and not less than 5280 feet in height where they are crossed by the high road from Nacaome to Tegucigalpa. They are cool, salubrious, and fertile, and literally constitute the granaries of the adjacent mineral districts. Wheat, potatoes, and especially maize have there a vigorous and productive growth".

Since the time of SQUIER cultivation of European cereals has largely disappeared; but successful efforts to revive wheat production are now being made by governmental and private agencies. Coffee has been developed as an export crop on a small scale. Tobacco, for which the region of Copán in the department of the same name has long been famous (it is said that Copán tobacco was exported in Colonial days to countries as far distant as Peru) is now grown principally for consumption within the republic. Cultivation of sugar cane has increased since SQUIER's time; it is grown extensively on the Sula plain for the manufacture of white sugar, and throughout the highlands in small patches for making panela, or crude brown sugar, and rum.

Cacao cultivation is of no present importance. There may be possibilities of developing this crop for export, if strains of high quality are planted. Fibers such as sisal and henequen have been given consideration, but have not proved profitable, due mainly, it is said, to difficulties of transportation.

There are no plateaux in Honduras at elevations such as are found in northwestern Guatemala; nevertheless, there are suitable areas at 5000 to 6000 feet, particularly in the Department of Intibucá, for temperate fruits such as apples, peaches, plums, and the like. The cultivation of these could well be expanded for local consumption. So, also, might the cultivation of tropical fruits such as oranges, mangos, and avocados, which thrive in the valleys of moderate elevation and on the dryer parts of the coastal plains.

Many regions, especially in the north, abound in excellent timbers, some of which are suitable for export and are exploited as market conditions warrant. Honduras or broad-leaved mahogany (*Swietenia macrophylla*) is one of the most important. Lignum vitae (*Guaiacum*), and Spanish cedar (*Cedrela mexicana*) are also valuable at times, while there are many trees the wood of which is used locally. There are excellent possibilities for reforestation on the mountainsides of the interior.

The development of the banana industry on the north coast, which commenced in the early 1900s, has been the outstanding agricultural achievement of modern times, and this industry today constitutes the nation's chief source of revenue. For several years, around 1925-1930, Honduras was the world's greatest producer of bananas, shipments reaching as much as 25,000,000 bunches in a single year. The fact that the industry has declined somewhat, due mainly to the ravages of Sigatoka disease, again has emphasized the need for diversification - a need which has been stressed by far-seeing Honduraneans for many years.

Coffee is not likely to achieve great importance, due to the lack of good lands at suitable elevations as well as scarcity of labor. With a view to developing other export crops, the United Fruit Company, through its subsidiary the Tela Railroad Company, established in 1925 an agricultural experiment station in the Lancetilla valley near Tela, on the north coast. Here were brought together crop plants from all parts of the tropics: Hevea or Pará rubber; all possible sources of tung oil (trees of the genus *Aleurites*); African oil palms (*Elaeis guineensis*); chicle (*Achras zapota*); Abacá or Manila hemp (*Musa textilis*); Oriental timber bamboos, and many others. In addition, the station possesses the most extensive collection of tropical fruits in Latin America, including varieties of the mango from Java, the Philippines, India, Florida, and the West Indies; several varieties of the lychee (*Litchi chinensis*); the rambutan and pulasan (*Nephelium lappaceum* and *N. mutabile*); the largest orchard of mangosteens in the western hemisphere; the durian (*Durio zibethinus*); and many rare varieties of *Citrus*.

In 1940 the experimental planting of Pará rubber at Lancetilla was turned over to the U. S. Department of Agriculture, which in co-operation with the government of Honduras has undertaken here the propagation of rubber on an extensive scale, utilizing high-yielding clones from the Asiatic tropics. It is considered by experts of the U. S. government that there are large areas on the north coast of Honduras suitable for rubber cultivation. It is to be noted that South American Leaf Disease (*Dothidella*

*ulei*) has not yet been found in this region.

African oil palms and other oil-yielding plants (sesame, peanuts) are being tested in northern Honduras. Experiments looking toward production of certain essential oils are also under way. Rice cultivation is being expanded. Citrus fruits have come in for attention: there is a small export trade in the vicinity of La Ceiba.

In addition to the need of more export crops, Honduras presents a second problem of perhaps equal importance: the desirability of increasing the production of subsistence crops. As in other parts of Central America, the diet of the highland peoples in particular is not sufficiently varied. This subject demands attention.

The government of Honduras has not, up to now, been able to count upon the services of a well-organised, adequately staffed department of agriculture, necessary for facing these problems in an effective manner. But the situation is gradually changing. The work done at Lancetilla Experiment Station during the past 15 years has been of assistance, as also that of the Research Department of the Tela Railroad Company, which maintains a laboratory at La Lima, near San Pedro Sula, where are conducted soil and fertilizer investigations, pathological studies, and agricultural experiments of various sorts. It was through the activities of this laboratory that control methods were developed for Sigatoka (*Cercospora musae*), a leaf-spot disease of bananas which appeared in tropical America about 1932 and in the succeeding five years threatened the banana industry of the entire Caribbean region.

The United Fruit Company has recently acquired a tract of land in the Zamorano valley near Tegucigalpa, where at an elevation of 2500 feet in an area typical of the Central American uplands, an agricultural school is being developed at which attention will be devoted to plant introduction and agricultural experimentation as well as preparation of Latin American youths in the various branches of tropical agriculture.

Experimentation of much value to Honduras has been done by the Standard Fruit Company at La Ceiba; by the late Don MANUEL GARCIA at his Birichiche plantation near Tela; by the PEREZ ESTRADA brothers at San Pedro Sula, where they have assembled an extensive collection of economic plants; and by others. The time is now arriving when much of this work should be supplemented by more specialised investigation.

ESCUELA AGRÍCOLA PANAMERICANA,
TEGUCIGALPA, HONDURAS.

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P. C. STANDLEY and J. A. STEYERMARK: **The Vegetation of Guatemala, a Brief Review**:- Guatemala, northernmost Central American republic, with an area of 48,290 square miles, has approximately the same size as the state of Mississippi. It is part of the ancient Central American land mass, and at least its southern portion has remained above sea-level since the end of the Paleozoic era. Mesozoic and Miocene-Pliocene seas severed its earlier attachments to Mexico, but since Upper Pliocene it has been connected to that country. Its connections with South America have existed since the Upper Miocene. Along its southwestern Pacificward portion occur 14 major volcanoes, of which Tajumulco is the highest in all Central America, reaching an elevation of 13,680 feet. These volcanoes extending near the coast in a northwest-southeasterly direction were formed during late Cretaceous and by Pliocene time their present heights had been completed. They bridge the gap, with other Central American volcanoes formed during this period, between the Pacific Cordillera of the western United States and Mexico and the Andean chain of South America. This chain of volcanoes has served as a path of dispersal for the southward migration of more northern species during the reduced temperatures of Pleistocene times, and, moreover, has acted as an effective geographic barrier in preventing most species of northern and eastern Guatemala from reaching the Pacific or western slope of Guatemala. The main central portion of Guatemala, however, consists of a series of mountain ranges which trend in an east-west direction and geologically are much more ancient than the volcanic area to the south and have a different origin. This portion consists of sedimentary as well as metamorphic and igneous rocks of Paleozoic, Mesozoic, and early Tertiary age. The northern third of Guatemala, including all Petén, consists of a relatively low region, mostly below 1200 feet altitude, made up of sedimentary formations chiefly of limestone of Mesozoic and Cenozoic age. The coastal plain of the Pacific coast is of Quaternary age, while the lowlands of the Atlantic coast region on the north are of Quaternary and Tertiary age.

The exceedingly varied types of soil and topography and diverse geological history of the country, ranging from ancient mountain masses connected with North America to relatively youthful volcanic areas, combined with marked altitudinal and climatic variations — hot desert to cold alpine regions — have given Guatemala the richest flora in all Central America with an estimated total of 8000 species of vascular plants. Of this number, many are endemics confined to particular canyons and volcanoes. Many genera and species of the United States and Mexico reach their

southern limits of distribution in Guatemala, while a large number of South American genera and species either reach their northern limits of dispersal here or are unknown elsewhere from other parts of Central America. *Orchidaceae*, *Leguminosae*, and *Compositae* are especially prominent, and include hundreds of species, many of which are not found outside of Guatemala.

The great diversity of the country is responsible for the following large number of floristic regions: (1) the limestone plains of Petén; (2) the mangrove swamps along both coasts; (3) the rain forest of the Atlantic coast; (4) the low savannas of Izabal and Petén; (5) the mixed forest of the Pacific plains; (6) the arid desert plains-chaparral of the plateaus of the Oriente and valleys of the Río Motagua and Río Blanco (also called Río Negro); (7) the wet mountain forest of Alta Verapaz; (8) the mixed mountain forest of the Pacific bocacosta; (9) the upland mixed forest of temperate and cold regions; (10) the coniferous forests; and (11) the alpine regions — in all 11 floristic regions, some of which may be further subdivided.

(1) The limestone plains of Petén include a vast region having a wet and a dry season with both the humid and arid tropical flora developed. Much of the flora is identical with that of the Yucatan Peninsula and includes many endemic species, while some of the flora, especially that of southern Petén, is more closely related to that of southern British Honduras and adjacent Guatemala. Broad-leaved forests of *Achras Zapota*, *Swietenia macrophylla*, *Brosimum Alicastrum*, *Rheedia edulis*, *Lucuma campechiana*, *Calophyllum brasiliense* var. *Rekoi*, *Cryosophila argentea*, and species of *Ficus*, *Piper*, and *Psychotria* are common occupants of the uplands of northern Petén, while in southern Petén a similar facies is evident. Lakes, wooded swamps, undrained sinkhole ponds or aguadas, and stretches of grassland are scattered throughout, especially in central Petén, but in general the country is densely forested.

(2) The mangrove swamps of the Atlantic and Pacific coasts have a nearly uniform flora consisting chiefly of *Rhizophora Mangle*, *Laguncularia racemosa*, *Conocarpus erecta*, and *Avicennia nitida*.

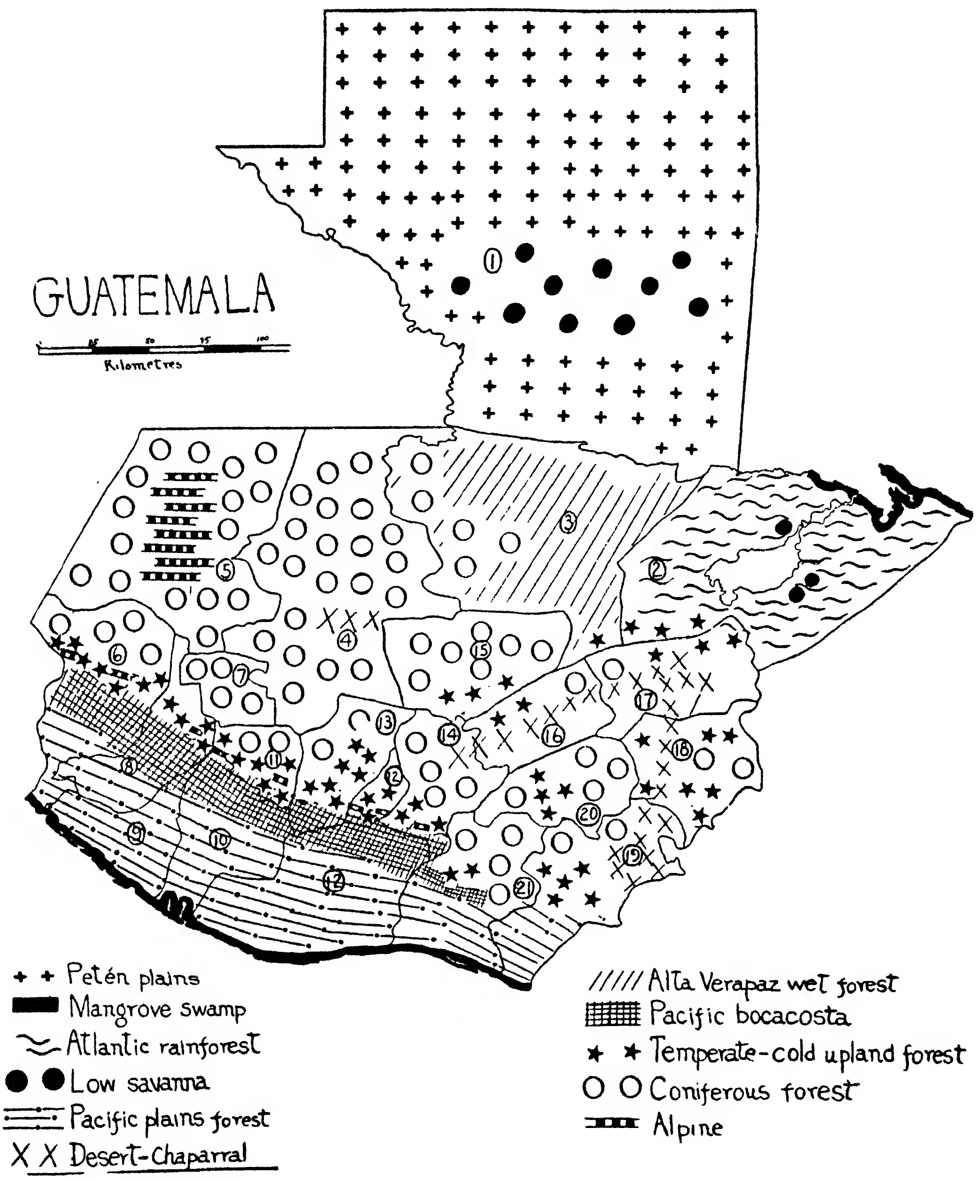
(3) The wet low rain forests of the Atlantic coast possess a very luxuriant flora, mostly derived from that of South America and Atlantic Central America, but also containing a large number of endemic species. The entire area is included in the humid tropical zone. Many kinds of palms, including *Orbignya Cohune*, *Cryosophila argentea*, *Hexopetion mexicanum*, several species of *Chamaedorea*, and *Calyptogyne Donnell-Smithii*, are scattered throughout a dense forest, composed in part of *Andira inermis*, *Calocarpum mammosum*, and species of *Ficus*, *Entada gigas*, *Bauhinia hondurensis*, and many species of *Araceae*, are characteristic climbers, while *Bromeliaceae*, *Orchidaceae*, *Peperomias*, and many kinds of mosses and hepatics cover the branches of trees in dense masses. Many species of this region are not found elsewhere in Guatemala, although some are also found in the Pacific bocacosta.

(4) The low savannas of Izabal and Petén are characterized by open stands of *Pinus caribaea*, *Curatella americana*, and *Byrsonima crassifolia*. Many species of *Gramineae*, *Cyperaceae*, *Leguminosae*, and *Compositae* abound. A number of species of these savannas do not occur elsewhere in Guatemala.

(5) The mixed forests of the Pacific plains comprise a relatively level region near the Pacific coast, characterized by a pronounced wet and dry season and hot temperatures. A diverse forest exists, much of which is of a scrubby type. Some of the commoner species are *Tabebuia pentaphylla*, *Ceiba pentandra*, *Gliricidia sepium*, *Bursera Simaruba*, *Cochlospermum vitifolium*, and *Sterculia apetala*. Most of the species found in this region are widespread types scattered along the Pacific coast from Sinaloa, Mexico, to Panama.

(6) The desert-chaparral region of Guatemala is one of the most interesting, since it includes many species either endemic to Guatemala or isolated in this portion of Guatemala and known elsewhere only in Mexico or parts of South America. *Ruprechtia Deamii*, *Crescentia alata*, *Juliania adstringens*, *Karwinskia Calderonii*, *Jacquinia aurantiaca*, *Erythroxylon fiscalense*, species of *Cassia*, *Acacia*, and *Bursera*, as well as various cacti, such as *Cephalocereus Maxonii*, *Lemairocereus Eichlamii*, *Acanthocereus pentagonus*, and *Pereskia autumnalis*, are characteristic shrubs, while *Portulaca pilosa*, *Talinum triangulare*, *Sida angustifolia*, *Conobea pusilla*, *Gomphrena decumbens*, *Diodia teres*, *Evolvulus alsinoides*, *Fimbristylis Preslii*, species of *Cyperus*, *Aristida*, *Bouteloua*, and *Panicum*, and many kinds of legumes and composites abound among the herbaceous plants. The chaparral-grassland plateaus of the departments of Chiquimula and Jutiapa are highly interesting also because of a small element of the South American flora isolated here, and often unknown elsewhere in Central America. Such species as *Scleria Lindleyana*, *Echinodorus grandiflorus* and *E. paniculatus*, *Eichhornia Schultesiana*, *Limnobium stoloniferum*, *Phoradendron emarginatum*, *Bacopa axillaris*, and *Pacourina edulis* are examples of South American species known elsewhere only in Guatemala or scattered in other remote parts of Central America. The genus *Crumenaria* is known only in South America with the exception of one species, *Crumenaria Steyermarkii*, confined to Guatemala.

(7) The wet forests of Alta Verapaz possess an extremely rich and diversified flora. A large variety of palms grow here, while *Vochysia hondurensis*, *Engelhardtia guatemalensis*, *Calocarpum viride*, *Hymenaea Courbaril*, and *Persea Schiedeana* are common trees and shrubs. Isolated in these forests are also such northern genera as *Magnolia*, *Berchemia*, *Gelsemium*, *Liqui-*




GUATEMALA AND ITS VEGETATION: 1, Petén; 2, Izabal; 3, Alta Verapaz; 4, Quiché; 5, Suchitepéquez; 11, Sololá; 12 (upper), Sacatepéquez; 12 (lower), Escuintla; 13, Chimaltenango; 14, Guatemala; 15, Baja Verapaz; 16, El Progreso; 17, Zacapa; 18, Chiquimula; 19, Jutiapa; 20, Jalapa; 21, Santa Rosa.

*dambar*, *Carpinus*, and *Rhus*. This region has abundant rainfall the year round, and accordingly possesses one of the richest floras of Guatemala. It is especially rich in its abundance and variety of *Orchidaceae* and *Bromeliaceae*. The "monja blanca", *Lycaste Skinneri* f. *alba*, the national flower of Guatemala, is wild in this portion of the country.

(8) The mixed forests of the lower and middle humid slopes (bocacosta) of the mountains (up to 3000 feet) bordering the Pacific coast possess a rich diversified flora similar to that of the low rain forest of the north coast of the Atlantic. It is in these forests at an elevation of 2000-4000 feet that tree ferns attain maximum growth and abundance. Rain is plentiful much of the year and there is a great variety of palms, ferns, vines, and epiphytes. Characteristic trees and shrubs include *Dussia cuscatlanica*, *Erblichia xylocarpa* var. *mollis*, *Billia colombiana*, *Sloanea ampla*, *Heisteria macrophylla*, *Luania mexicana*, *Mollinedia guatemalensis*, and *Louteridium mexicanum*. A large number of species found in the bocacosta are endemic or elsewhere known only from Chiapas and

Oaxaca, Mexico, or in other cases are related to species of Costa Rica, Panama, and South America.

(9) A large portion of Guatemala above 5000 feet possesses upland mixed forests of broad-leaved species. It is a forest which comprises xerophytic as well as moisture-loving (including cloud forest) types of plants. Most of the cloud forests in Guatemala occur at an elevation between 4500-7000 feet, and have a rich development of tree ferns, orchids, begonias, bromeliads, aroids, and bryophytes. Many endemic species are found in these cloud forests. Species of *Quercus, Ilex, Prunus, Heliocarpus, Alnus, Oreopanax xalapense, Garrya laurifolia, Olmediella Betschleriana, Ostrya virginiana* var. *guatemalensis, Cestrum aurantiacum, Sambucus oreopola* and *S. mexicana, Turpinia occidentalis, Cornus disciflora, Roupala loranthoides, Dahlia pinnata*, and *Geranium mexicanum* are characteristic. *Cheiranthodendron pentadactylon* is abundant in the higher upland forests of central and western Guatemala. The endemic composite, *Rojasianthe superba*, is confined to the moist upper mixed forested slopes of the western volcanoes.

(10) The coniferous forests of Guatemala constitute an assemblage of several floristic regions, consisting of various types, each with a characteristic flora. This type of forest is the common one throughout the Guatemalan highlands, chiefly at 5000-12,500 feet. The genera *Cupressus, Juniperus, Abies*, and *Taxodium* reach their southern limits of distribution in Guatemala. In the Sierra de los Cuchumatanes are extensive areas of *Juniperus* forest, often in association with pine. Pure or mixed stands of pine (*Pinus oocarpa, P. strobiliformis, P. Ayacahuite*, and *P. Montezumae* and varieties) occur, or in the higher elevations of 8000-11,000 feet *Abies guatemalensis* may be mixed with *Cupressus lusitanica* or *Pinus Ayacahuite. Buddleia megalocephala* and *Oreopanax capitatum* are common trees, while *Rubus trilobus, Fuchsia cordifolia, Lycianthes quichensis, Pernettya ciliata, Acaena elongata, Oxylobus glanduliferus, Arracacia Donnell-Smithii*, and species of *Alchemilla* are frequently found.

Lastly, (11) the alpine regions of Guatemala, practically confined to open places on tops of the volcanoes, usually above 10,000 feet, and on to the high plateaus of the Cuchumatanes of northwestern Guatemala, constitute a distinct floral area. These alpine regions consist of small or extensive open patches of dwarf herbs and sometimes shrubs not found elsewhere in Guatemala. A number of species confined to these high altitudes are endemic, or otherwise known from either the Andes of South America or the highest peaks of Mexico or central America. Some are closely related to alpine species found far north in the Rocky Mountains of the United States, and may be regarded as Pleistocene relics which migrated southward as a result of reduced temperatures existing at that time. Characteristic of this region are *Draba vulcanica, Arctostaphylos craterioola, Luzula racemosa, Geranium alpicola, Aplopappus stoloniferus, Gnaphalium vulcanicum, Arenaria bryoides* var. *guatemalensis, Vaccinium Selerianum, Werneria nubigena, Weldenia candida, Muehlenbeckia vulcanica, Alchemilla pinnata, Potentilla heterosepala*, and many species of grasses, principally species of *Festuca* and other northern genera.

Scattered throughout Guatemala are other distinct floristic areas, confined to salt flats, sulfur deposits, lakes at various elevations, and swampy meadows.

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WILSON POPENOE: **Plant Resources of Guatemala**:- In considering the plant resources of their country, Guatemalans commonly think of the latter as divided naturally into five zones, as follows:

1. *The central highlands*, a broad area extending from the Mexican frontier to the borders of Salvador and Honduras, mountainous in character with intervening plateaux and small valleys lying at elevations of 2000 to 8000 feet. Here is concentrated most of the country's population, and here was centered Indian agriculture in pre-Columbian times. Many parts of the region have excellent volcanic soils, sandy loams to clays, and moderate rainfall (about 35 to 50 ins. annually) distributed in well-defined wet and dry seasons of approximately equal length. The rains usually commence in April-May and terminate in November-December. The higher mountainsides are covered in many places with stately forests of pine and oak. The agricultural lands - still largely in the hands of the Indians (except toward the Salvador-Honduras side, known as the Oriente) - are cultivated in corn, beans, and other subsistence crops. Above 6000 feet, approximately, tender plants such as bananas are injured by frost. Citrus fruits and avocados grow up to 7500 feet.

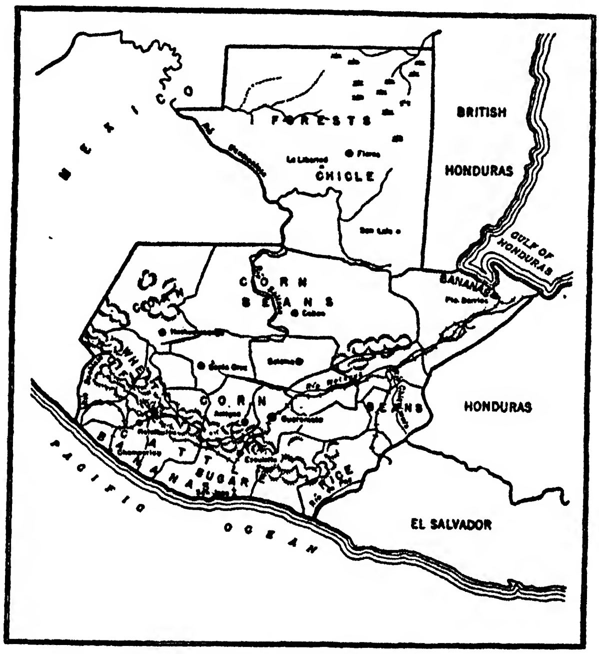
2. *The Pacific region*, scene of most of the country's large-scale agriculture with exception of the banana industry in the Motagua valley on the north. Commencing on the higher slopes of the volcanic chain

which parallels the seacoast, this zone extends down to the latter, including the fertile coastal plain about 30 miles in width. The soils, except some of those toward the Mexican border, are mainly volcanic sandy loams to light clays, deep and of excellent agricultural quality. Rainfall is heavy in the upper part of this zone (sometimes as much as 150 to 200 ins., with only two or three dry months), low toward the littoral, where it may be only 25 or 30 ins., all of which falls between May and November. Coffee is the main crop between 2000 and 5000 feet. In the vicinity of Mazatenango, San Felipe and San Antonio, at elevations between 1000 and 2500 feet, Soconusco cacao, considered to be of excellent quality, was grown for export in Colonial days. Its production declined until the supply was no longer adequate to meet local needs, but is once again increasing. At low levels on the coastal plain bananas and sugar cane are extensively grown, often with irrigation; while cattle-raising is important, and subsistence crops such as corn and beans are planted in the wet season.

3. *The Alta Verapaz*, a somewhat isolated mountainous Department in the north, characterised in parts by limestone soils devoted largely to coffee cultivation, and to Indian (subsistence) agriculture. There are no high elevations in comparison with those of the central highlands; the cultivated areas lie mainly between 2000 and 5000 feet, and have a well-distributed rainfall of 80 to 120 ins. per annum.

4. *The Motagua valley*, running from the center of the country in a northeasterly direction to the Atlantic. In its central portion the valley floor varies from 250 to 500 feet in elevation. The soils, with exception of those on the narrow *vegas* or flood-plains along the river and its tributaries, are mainly coarse sandy or gravelly clays, which combined with low rainfall give the region a semi-arid appearance. Toward the lower end of the valley, from Gualán to the sea, and in the adjacent Polochic-Izabal valley to the north, the natural vegetation is tropical rain forest (precipitation 80 to 120 ins. annually) and the alluvial lands are cultivated in bananas, with smaller areas in corn, rice and other subsistence crops.

5. *The immense rolling plain of Petén in the north,* occupying about one-third the total area of the republic. This is a low, almost unpopulated region of limestone formation, yielding for export a few hardwoods and chicle (obtained by tapping wild trees of the genus *Achras*), and limited quantities of corn and other subsistence crops. Elevations commonly range from 500 to 700 feet above sea level; there is a well-marked dry season.




AGRICULTURAL REGIONS OF GUATEMALA
(*Courtesy of Agriculture in the Americas*)

At the time of the Spanish conquest (1523-1524) those parts of Guatemala which were the most fertile and possessed the most salubrious climates were farmed by numerous Indian tribes related to the Maya of Yucatán and (in a few instances) to the Aztec of Mexico. They grew corn, beans, and squashes; chile peppers (Capsicums) and güisquiles (*Chayota edulis*); while in their dooryards, according to the climate in which they were situated, flourished cacao trees; pacaya palms (*Chamaedorea*) with edible inflorescences; avocados, jocotes (*Spondias purpurea*), zapotes (*Calo-*

*carpum mammosum*), several kinds of Annonas, and other fruit-bearing trees.

During the last half of the XVI century, cacao was exploited by the Spaniards as an export crop. By 1600, however, its importance was declining and indigo was coming to the fore. Wheat, barley, and other European crops had been introduced for subsistence purposes, and were cultivated with more or less success in the highlands. Sugar cane had also been brought from Europe, as had the citrus fruits, plantains, and several vegetables. Grapes and olives had been planted, but it seems doubtful that their cultivation was very successful, for the latter have disappeared entirely, while the former do not succeed well today.

Coffee, most important of modern export crops, was introduced about the middle of the XVIII century, but did not become extensively grown until much later. In the meantime indigo had been replaced in large part by cochineal, which in turn became unprofitable due to the use of aniline dyes. Toward 1875 coffee cultivation began to increase rapidly, while shortly after 1900 the banana industry began to develop in the lower Motagua valley and around Lake Izabal, later to be extended to the Pacific coast. These two crops, coffee (about one million cwt.) and bananas (6 to 10 million bunches annually) now account for some 90% of Guatemalan exnorts. Mining is of little importance; cattle are reared to supply the local demand for beef; and sheep are grazed on the highlands (mainly at 6000 to 11,000 feet) to supply part of the demand for wool.

Agriculturally, Guatemala is one of the most self-sufficient countries of the American tropics. Though its economic prosperity may be (and often is) affected by fluctuations in the coffee market, its subsistence needs are met locally to a remarkable degree. Corn and beans are the basic foodstuffs, particularly among the Indians (who constitute some 80% of the total population); there is sufficient wheat produced in the highlands (6000 to 8000 ft.) to meet part of the demand for wheat flour and more could easily be grown. Sugar cane is cultivated widely up to elevations of 5000 feet. Production is adequate to meet demands for panela (crude brown sugar), white sugar, and rum; indeed it has had to be restricted in recent years through a quota system. Some cotton is grown, but not sufficient for present local requirements. The near future will probably see an increase in this crop. Rice production has been expanded considerably during the past few years. The country is rich in tropical fruits, such as oranges, mangos, avocados, and pineapples; while in the highlands at 6000 to 8000 feet there is a small but increasing production of such temperate-zone fruits as apples, peaches, pears, plums, and strawberries. Tobacco is grown for local use.

There are many good timbers available, and a small export trade in several. In the central and northwestern highlands at elevations of 8000 to 11,000 feet grows the native cypress (*Cupressus Benthami*), much-used for construction purposes; also several species of *Pinus* and the native fir or pinabete, *Abies religiosa*. On the lowlands of both coasts are Honduras or broad-leaved mahogany, *Swietenia macrophylla;* Spanish cedar (*Cedrela mexicana*); guayacán or lignum vitae (*Guaiacum* spp.); palo blanco or primavera (*Tabebuia Donnell-Smithii*) all used locally and exported whenever the market warrants, in addition to several trees employed within the country for construction purposes and cabinet work. Wild rubber trees of the genus *Castilla* occur in several parts of the republic and have been tapped at times for exportation; their latex is used locally for making rain capes.

The government of Guatemala maintains a Department of Agriculture headquartered at Guatemala City which concerns itself with introduction of new crops; advice to planters on cultural problems and disease control; and similar matters. There are no agricultural experiment stations, but a well-equipped chemical laboratory is maintained in Guatemala City where soil analyses are made and agricultural products are examined. There is a small botanical garden in the edge of Guatemala City.

Forestry has received scant attention up to the present. There is need for work in reforestation, forest pathology, and above all, for erosion control in deforested areas. There is also need of more pathological work on control of coffee diseases (which fortunately are not yet serious in many areas), and for studies looking toward improvement of coffee cultivation through vegetative propagation of selected strains, better pruning, rational use of fertilizers, and erosion control in coffee plantations. The Department of Agriculture has plans for expanding its work along some of these lines; much may be accomplished, also, at the National Agricultural School in Barcenas, which is being equipped with a good laboratory for plant pathology and which has ample land for field experiments of many sorts.

Current activities of promise, on the part of governmental agencies and private planters, include the following:

Establishment of *Hevea* or Pará rubber cultivation in the republic. In this the government of Guatemala is coöperating with that of the United States, which sent in 1940 a survey party to choose suitable lands for rubber cultivation, and which is distributing seeds as well as budded plants of high-yielding clones. There are believed to be considerable areas suitable for this crop, both on the Atlantic and Pacific sides of the country.

Commercial development of *Cinchona* (quinine) cultivation. Attention was devoted to this subject as far back as 1880, but little was then accomplished, due most probably to lack of the right type of planting material. Extensive experiments are now under way in the coffee zone of the

Pacific side at elevations of 3000 to 6000 feet; and in the Alta Verapaz at 4000 to 5000 feet. The U. S. Department of Agriculture has coöperated in this work through supplying seeds and plants from many parts of the tropics; the Guatemalan government is also coöperating actively.

Improvement of sugar cane cultivation through introduction of superior varieties. One of these, POJ 2878, is now replacing sorts formerly grown in many areas, with an increase of almost 100% in yields.

Cultivation of kapok fiber (*Ceiba* sp.), a tree native to Guatemala; and of henequen, which has been planted in the Alta Verapaz, where its product is used for cordage, mats, etc., sold locally. It seems probable that national needs for coffee and other bags (imported in the past from India, Salvador, and Mexico) will shortly be met by henequen or other fibers grown within the country.

Experiments looking toward the production of tung and other industrial oils. Tung (*Aleurites montana*, not the species grown in Florida, which latter is *A. Fordi*) is growing satisfactorily in the Alta Verapaz at 4000 feet and at several places on the Pacific side, but it is not yet clear that good yields will be obtained.

Cultivation of citronella (*Andropogon nardus*) and lemon grass (*A. citratus*) for oils which are already being exnorted from the region of Escuintla on the Pacific side.

Tests of rotenone-yielding plants such as *Derris elliptica*, and further exploitation of medicinal plants such as sarsaparilla.

From the above it will be noted that there is at present much interest in crop diversification, despite the fact that Guatemala has never been so dependent upon one crop as have many other tropical countries. While these activities are not wholly of recent inception - for example, tea has been grown commercially in the Alta Verapaz for many years, also cardamoms and to a small extent, vanilla, - interest today is keener than it has ever been in the past.

ESCUELA AGRÍCOLA PANAMERICANA,
TEGUCIGALPA, HONDURAS.

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**ALEXANDER F. SKUTCH: The Natural Resources of Costa Rica**:- Costa Rica is a land of exceedingly mountainous topography, which before the arrival of man must have been almost everywhere forested, from the seashore up to the summits of all but a few of the highest mountains. Even after 4 centuries of occupation by white men, forests cover possibly three-quarters of the country. The plains and foothills of the Caribbean side, where there is abundant rainfall throughout the year, support heavy tropical rainforest. On the Pacific side, south of the Gulf of Nicoya, the forests are also very tall and heavy, despite the fact that the first three months of the year are frequently rainless or nearly so. But northward from the Gulf of Nicoya, in the Province of Guanacaste, the longer and more severe dry season has brought about the development of lower, more open woodlands of semi-arid type, which in many parts occur in belts interrupted by extensive grassy openings that were probably formed long ago by repeated burning. These *sabanas* support large herds of half-wild cattle. Heavy forests, dominated as a rule by huge oak trees, cover the upper slopes of the mountains up to at least ten thousand feet, and in places even higher. On the loftiest summits of the Cordillera de Talamanca the trees gradually become lower, until at about 11,000 feet they give way to the bushes, low bamboos and coarse grasses of the páramos. The páramo formation, typically Andean, here reaches its northern limit.

The densely populated and intensively cultivated portion of the country forms a narrow transverse belt lying somewhat north of the center. This belt is widest on the Pacific side of the Continental Divide, where it includes the Central Plateau, the more accessible mountains lying north and south of it, and the valley of the Río Grande de Tárcoles flowing down to the Pacific. Toward the Caribbean, the contracted belt of cultivation follows the profound, steep-sided valley of the Río Reventazón, expanding along some of its larger tributaries, thence continues over the lowlands along the line of the railroad to Puerto Limón. North and south of this zone of cultivation stretch vast, scarcely broken forests traversed only by difficult mule-trails. In the midst of these forests lie a few isolated communities which within recent years have been made more accessible by aviation. Perhaps the most important of the outlying regions whose transportation is based upon the airplane is the basin of El General in the southern Pacific section of the country, where population and agricultural development are rapidly increasing. The Pan-American Highway, now under construction, is destined to pass through this basin, thence to continue down the Térraba Valley toward the frontier of Panama, opening an extensive region to settlement and exploitation. Finally, there are the banana plantations and scattered settlements along the coasts, accessible by water.

Although Costa Rica supports many small establishments for the fabrication of some of the simpler manufactured articles, such as shoes, tiles, furniture and clothing, it is essentially an agricultural country. The production of COFFEE is its most im-

portant industry. The crop is grown chiefly at altitudes between 2000 and 5500 feet; the most valuable grades come from the higher elevations; and the growing of coffee at low altitudes is discouraged. In pruning the young trees, the terminal shoot is cut away, which causes the uppermost remaining pair of lateral buds to grow out and form two upright replacement shoots. The following year, these shoots are in turn decapitated; and each is replaced by a pair of upright branches. Thus, in the ideal case, a symmetrical, dichotomously branched bush is produced, very different in aspect from that formed by the Guatemalan system of bending over the young plant and causing new shoots to spring up from its base.

The coffee plantations are shaded chiefly by leguminous trees such as the guabo and cuajiniquil (*Inga* spp.) and to a less extent the poró (*Erythrina* spp.). Compared with Guatemalan practice, the shade trees are kept very low and open by heavy pruning. Bananas and plantains are often used as subsidiary shade, or to give temporary shade to new plantations until the permanent shade trees have had time to grow.

The majority of the Costa Rican coffee plantations are small and are not equipped with *beneficios*, or mills for cleaning and drying the "beans". The freshly picked berries are in these cases delivered for processing to some large, centrally located *beneficio*. In 1939, Costa Rica exported 20,244,531 kilos of coffee valued at 4,644,301 dollars.

A troublesome pest of the coffee is the *ojo de gallo*, caused by a fungus (*Omphalia flavida*) that attacks leaves and fruit. It is controlled by spraying and reducing the density of the shade.

Bananas, next to coffee, form the most important export crop of the country. The banana industry was first developed in the Caribbean lowlands, whence the fruit was exported through Puerto Limón. The Panamá disease (*Fusarium cubense*) has quite ruined the big banana plantations on this side of the country; and very little fruit is now produced there. Much of the fruit now shipped from Limón comes from the mature far more slowly than in the low-Reventazón Valley and even the central highlands, along the line of the railroad. Some of the bananas for export are grown as high as 4500 feet, where of course they lands. The center of banana production in Costa Rica has now shifted to the Pacific coast, south of Puntarenas, where two new divisions have recently been developed by the United Fruit Company, at Parrita and about the Golfo Dulce. The new plantations are attacked by the Sigatoka disease (*Cercospora musae*), which necessitates considerable expenditures for spraying. In 1939, Costa Rica exported 3,429,787 racemes of bananas valued at 1,911,084 dollars.

Plantains of various forms are an important element in the native diet, but are rarely exported.

Cacao has been extensively planted in the Caribbean lowlands, but its importance has waned in recent years. In 1939, the country exported 7,672,374 kilos of cacao valued at 1,150,856 dollars.

Sugar-Cane is grown on both coasts, and in the central highlands up to an altitude of about 5500 feet. A certain amount of the product is refined to form white sugar, but this does not always suffice for the internal consumption. The humbler elements of the population use their sugar in the form of *dulce*, which is sold in solid round bricks made by boiling the cane juice in a large open basin until it will solidify upon cooling, then pouring it into wooden moulds of the desired form. The only purification consists in removing the foam from the boiling liquid with a strainer. A large proportion of the *dulce* is made at home in tiny ox-driven *trapiches* housed under thatched roofs. *Dulce* is used for sweetening coffee and other drinks, or, dissolved by itself in hot water, to form the popular beverage known as *agua dulce*.

### *GRAINS*

Maize, the most important cereal crop, is grown from the coasts up to an altitude of about 9000 feet. In the lowlands, the grain is ready for harvest five months after planting; but on the Volcán Irazú, 9000 feet above sea-level, are fields in which the maize is planted in January and harvested in January of the following year. On the Pacific side of the country, where the dry season is pronounced, the principal crop of maize is sowed in March, just before the beginning of the rains. A subsidiary crop may be planted during the wet season, to mature at the outset of the following dry season. A great deal of maize is used in the preparation of *tortillas*. These broad, thin disks of unleavened maize are the staple breadstuff of the poorer people from Mexico to Costa Rica; but I have never met them to the south of this country. Much maize is also used for fattening hogs.

Rice is produced chiefly on the Pacific side of the country, at elevations below 2500 feet. Although in California and again in Colombia rice is grown in flooded or naturally marshy paddy-fields, in Central America I have seen it only in well-drained lands such as might be used for maize. Sometimes the stools are left in the fields after the main crop has been harvested, and a rattoon crop is produced. As in most tropical countries, boiled rice is a staple element in the diet.

Adlay, a thin-shelled variety of the widespread and well-known Job's-tears (*Coix Lachryma-Jobi*), is grown on a small scale, chiefly on the Pacific side of the country. Its cultivation has scarcely passed the experimental stage, and was apparently more widespread a few years ago than it is today. Flour is made from the grain; but this is deficient in gluten and must be mixed with wheat flour to obtain sufficient cohesiveness for baking bread and cakes. The seeds are also fed to poultry. Considerable interest in this grain, as a possible substitute for wheat in the lowlands, is now being taken in various parts of

tropical America; but it remains to be seen what importance it will assume.

WHEAT, an important crop in the highlands of Guatemala, Ecuador, Perú, etc., is not produced in Costa Rica, save perhaps as a curiosity; but great quantities are imported. Barley, oats and rye are practically unknown.

BEANS, rice and *tortillas* of maize are the mainstay of the Costa Rican peasant and laborer; and of these articles of diet the least dispensable is the bean. Black beans are the favorite, but red and white are also used in smaller quantities. Tons of beans are now shipped by airplane from the isolated basin of El General to the markets of the central plateau.

CUBASES (*Phaseolus coccineus*) are large, slightly flattened, brownish beans, bearing a slight resemblance to the lima-bean, grown in the Cantón de Dota and El General.

### *VEGETABLES AND ROOT CROPS*

The CHAYOTE, or cho-cho, a somewhat pear-shaped fruit of a cucurbitaceous vine (*Sechium edule*) is distinguished from most related productions by the presence of a single very large seed, which has an agreeable, nut-like flavor. This is one of the most widely used vegetables of the country. The vine reaches its best development when trained over an arbor; but on the Caribbean slope it is planted extensively on precipitous mountainsides where it is allowed to trail over the ground. In addition to the fruits, the thick root is frequently eaten as a vegetable, and sometimes also the tender new shoots.

Pumpkins (*ayotes*) and squashes (*zapayos*) are also frequently planted. In the highlands, many familiar vegetables of the temperate zones are grown to supply local markets. Among these are beets, cabbages, cauliflowers, carrots, lettuce, radishes, turnips, etc. The potato is grown from 3000 to more than 9000 feet above sea-level. The yuca or cassava, the sweet-potato, the tiquisque (*Xanthosoma violaceum*), the ñampí (*X. sagittifolium*) are starchy root-crops widely planted at lower and middle altitudes.

### *FRUITS*

Although most tropical and a few temperate-zone fruits thrive in Costa Rica, only the banana is produced on a large scale for export. From time to time there has been sporadic activity in the exportation of pineapples and oranges, but this has never assumed real importance. Oranges, sweet lemons, lemons, avocadoes, mangoes, anonas, pineapples, ciruelas or Spanish plums (*Spondias* spp.), zapotes (*Calocarpum mammosum*) are the favorite fruits of the country people. The edible yas (*Persea frigida*), a near-relative of the avocado, grows wild in the forests at middle altitudes.

### *FIBER PLANTS*

CABUYA (*Furcraea Cabuya*), a plant resembling the maguey, is widely planted at middle altitudes, but almost always on a small scale. The tough fibers in its long, fleshy, swordlike leaves are used in the manufacture of cordage. Much rough but very serviceable string and rope is made by primitive means as a cottage industry; and near Cartago there is a small factory equipped with modern machinery for manufacturing rope.

ABACÁ or Manila hemp (*Musa textilis*) is planted on a small scale in the Caribbean lowlands; but this crop has not yet assumed importance.

BURÍO (*Heliocarpus* spp.) is a rapidly growing, soft-wood, native tree whose strong fibrous bark is widely employed for tying together ranchos, making hammocks, etc.

### *TIMBER*

The best lumber for building and furniture comes from the northwestern section of the country, especially the region about the Gulf of Nicoya, where the dry season is long and severe; but the country as a whole is heavily forested, and all accessible regions furnish a certain amount of lumber. The number of species used for lumber is very large; their botanical identification is made difficult by the confusion of local names, the frequent lack of flowering specimens, and the uncertainties attending their identification even after they have been obtained. Important timber trees of Costa Rica are the cedro or Spanish cedar (*Cedrela* spp.), mahogany, laurel (*Cordia alliodora*), pochote (*Bombacopsis Fendleri*), cocobola (*Dalbergia retusa*), and a large group of lauraceous trees variously designated ira and quizarrá (*Nectandra* and related genera).

### *MEDICINAL PLANTS*

IPECAC ROOT (*Cephaëlis Ipecacuanha*) is collected in the forests of the northern part of the country. In 1939, Costa Rica exported 14,039 kilos of this root valued at 15,409 dollars.

The agricultural development of Costa Rica has been retarded by lack of roads or other means of transportation. Only the relatively narrow central plateau is fairly well provided with all-weather roads. The great forested areas to the north and south have remained undeveloped because they are virtually without highways and therefore inaccessible. The building of the Costa Rican link of the Pan-American Highway will open extensive areas of wilderness to colonization and development.

Costa Rican agriculture has also suffered from lack of diversification and placing too much dependence upon a single crop: coffee. Since the production and exportation of bananas, important as it is to the country, has from the beginning been controlled by a foreign corporation, the prosperity of Costa Rica depends primarily upon coffee, which is a crop of the middle altitudes where the bulk of the population resides. During the years of high prices, this crop brought considerable wealth, which was to a lamentable degree - as in neighboring countries - spent abroad or for unnecessary luxuries rather than in laying the bases for the future development of the country. With present low prices, the

whole economic life of Costa Rica languishes. So exclusively has attention been focussed upon the cultivation of coffee that it has frequently been necessary to import staples such as beans, rice, sugar and even maize, all of which can readily be produced at home.

The great need of Costa Rican agriculture is diversification, to render the country as nearly as possible self-supporting, and to counterbalance the disturbing effects of fluctuations in the price of coffee. Recently attempts have been made to introduce new crops, such as abacá or Manila hemp, sesame, soy beans, adlay, and Brazilian rubber. Although some of these are promising, none has yet reached a position of importance. The Government of the United States, in coöperation with the Government of Costa Rica, is at the moment establishing well-equipped experiment stations whose aim is to lay the bases for the production of Brazilian rubber (*Hevea*).

A small agricultural school and experiment station is maintained by the Government at San Pedro de Montes de Oca, on the outskirts of San José. This institution performs valuable services in research and the dissemination of agricultural information; but in a country as diversified climatically as Costa Rica, there is need for subsidiary experiment stations situated in outlying regions at varying elevations.

A great desideratum of agriculture in Costa Rica, as in other humid tropical countries with a year-long growing season, is the substitution of perennial for annual crops. The conservation of the soil and the forests would be immensely simplified if perennial substitutes could be found for maize and beans, for the cultivation of which large areas of standing forest are annually sacrificed. Any change from these long-established staples would entail alterations in the dietary as well as the agricultural practices of the people; and doubtless a good deal of resistance would be opposed to innovations. But the advantages to be derived from the substitution of perennial crops should tempt some enterprising experiment station to institute researches with this end in view.

SAN ISIDRO DEL GENERAL,
COSTA RICA.

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ROBERT W. SCHERY: **A Few Facts Concerning the Flora of Panama**:- Panama is the southernmost of the Central American countries, and is of a sigmoid shape, with its long axis running in essentially an east-west direction. The total area of Panama is some 31,600 square miles; yet the country is at no point more than 120 miles wide and at its narrowest region only 40 miles wide (Canal Zone). Most of the land area has an altitude of less than 500 m., and nine-tenths of the territory has an altitude of less than 1200 m.

Geologically the region is quite young, having been a sea portal between the Atlantic and Pacific Oceans in early times, rising as a young land bridge between North and South America in the Cenozoic. In late Miocene, Pliocene, and through the Pleistocene there occurred in Panama an era of intrusive mountain making, accompanied in the later stages by intensely active explosive volcanoes, the cones of which form a distinctive floristic as well as a scenic feature today. Since Panama was land during most of the Cenozoic, sedimentary rocks of that era are few (Eocene, Oligocene, Miocene) and consist chiefly of thin marginal deposits mostly of shale, limestone, sandstone, and some conglomerate. Thus the "backbone" of Panama consists of an igneous and volcanic base (chiefly andesitic) onto which thin marginal sediments have been deposited. This "backbone" runs the length of Panama, and rises frequently to altitudes of over 1000 m. Thus with a continental divide so high in a region so narrow, steep slopes and irregular topography result. With erosion since the Miocene, there are no long continuous ridges or partly dissected plateaus, but rather precipitate slopes, hills covered with dense forest deeply rooted in decayed rock, and generally narrow beaches. To quote HILL*, the land is "rapidly eaten away by rains and vegetion, and the powerful marine gnawing along the coasts".

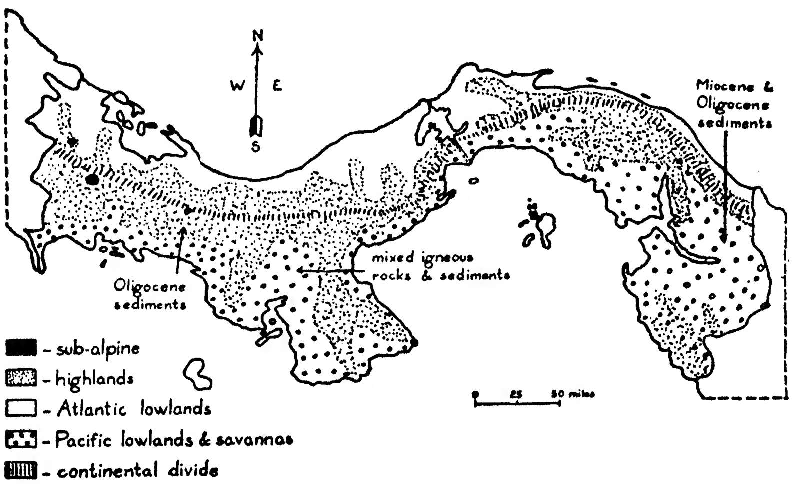
In country such as this most of the exposed "soil" rock is igneous. However there are some fairly abundant sediments in central Darien, and in Chiriqui. In the Azuero Peninsula occur mixed sediments and volcanics (see map).

In a region such as Panama it is apparent that the flora must have entered recently, geologically speaking. Since North and South America are both great land masses it is probable that an influx of types into the isthmus occurred both from the north and south when the young landbridge first formed. In any event, since late Cenozoic a rich flora has developed in Panama. In HEMSLEY's "Biologia Centrali-Americana" (1886-1888) over 1400 species are listed from Panama. Today there occur over 2000 species in the Canal Zone, and in a well collected area such as Barro Colorado Island alone 1259 species are known. Probably in Panama as a whole, with the high altitude Costa Rica-type flora of Chiriqui, the savanna flora of the Pacific slope, and much unexplored territory east of the Canal Zone yet to be reported, 7000-8000 species may be listed in a final Flora. Very prominent in such a Flora will be families of plants little found in the temperate latitudes such as the *Orchidaceae*, *Bromeliaceae*, *Araceae*, *Rubiaceae*, *Melastomaceae*, *Palmae*, *Sapin-*

*From SCHUCHERT, C., Hist. Geol. Antillean-Caribbean Region, 1935.

*daceae, Piperaceae,* families of the *Scitaminales,* etc.

Floristic regions in Panama can be separated latitudinally as well as altitudinally. Thus there is a distinctive quality of the flora of the more moist Atlantic slope not found in the flora of the dryer, more seasonal Pacific slope. Due to the prevailing trade winds blowing south-west into the high interior of Panama and precipitating their moisture as they rise, there is ample rainfall (ca. 330 cm./yr.) and no distinct dry season on the Atlantic slope. On the contrary, the rainfall of the Pacific watershed is about one-half that of the Atlantic and a distinct dry season occurs from January to April. On the Pacific side one finds more widely spaced forest and savanna lands with many grasses, sedges and legumes. But on the Atlantic side there are no savannas, denser forest prevails and there occur plants such as certain palms not found on the Pacific slope.




A MAP OF THE FLORISTIC REGIONS OF PANAMA (*Original*).

Then too, there is found regional differentiation due mainly to altitudinal differences into six intergrading floristic regions:

1) **Coastal beaches and swamps**
2) **Inland lake, pond and river areas**
3) **Lowlands**
4) **Savannas**
5) **Highlands**
6) **Sub-alpine regions of volcanic peaks**

Much of the coast of Panama is given over to mangrove swamp, a condition common to tropical America. Thus in the coastal swamps we find the omnipresent *Rhizophora, Laguncularia, Conocarpus, Avicennia;* on the coastal beaches *Coccoloba, Guilandina, Hibiscus tiliaceus, Ipomoea pes-caprae,* etc.

Due in part to the construction of the canal, Panama abounds in inland freshwater areas. Hence, about Gatun lake, small ponds, and water courses, can be found fresh-water aquatic and semi-aquatic plants such as *Sagittaria, Jussiaea, Polygonum, Pontederia, Heteranthera, Nymphoides, Castalia, Eichhornia, Pistia, Salvinia, Utricularia* and *Cabomba,* all more or less abundant.

The lowlands are humid, warm (temp. about 20°-35°C.) regions of "giant trees crowded together in dense forests, thickets of shrubs and enormous herbaceous plants set so closely together that a way through them must be cut with a machete".* Barro Colorado Island is typically such a region, having been set aside almost unmolested in its primeval condition, as indicated by the presence of such shade-loving plants as palms and tree-ferns. It is a well-drained, thick-forested area lacking an abundance of brilliant flowers, as do the lowland tropics generally. It is rich in rank herbs such as *Calathea* and *Heliconia,* lianas of the *Bignoniaceae,* and many forest trees such as *Chrysophyllum, Andira,* and *Ficus.* As typical of lowland areas, there are relatively few orchids. Families well represented in known species (as of 1933) include: Grasses—64, Palms—18, Aroids—40, Bromeliads—17, Legumes—85, *Rubiaceae*—59, species in *Scitaminales*—26. Also comparatively rich in species are the *Piperaceae, Moraceae, Anonaceae, Malpighiaceae, Euphorbiaceae, Sapindaceae, Passifloraceae, Melastomaceae, Solanaceae,* and *Bignoniaceae.* Prominent families with relatively few species represented include the *Liliaceae, Portulacaceae, Nymphaeaceae, Umbelliferae,* and even the *Compositae.*

The savanna regions occur only on the drier Pacific slopes and are extensively used as grazing land. They are parched and dry during the dry season, but with the advent of the first rains become luxuriantly green, often possessing ephemeral ponds and bogs in the low areas of their gradual slopes. Besides being rich in grasses and sedges, the savannas are characterized by such plants as *Polygala, Bor-*

*STANDLEY, P. C., Flora of Barro Colorado Island. 1933.

*reria, Ruellia, Lantana, Trema, Helicteres,* and many small legumes.

The highland regions are found in the Panamanian interior at elevations from about 900-2500 meters. Here the temperature is always agreeably cool or cold (5°-20°C.), and mists and light rains are frequent. This is as excellent a climate for growing coffee, as is the lowland region for growing bananas, abaca, and cacao. Endemic plants abundant in and characteristic of the highland regions include *Smilax, Piper* and *Peperomia, Solanum, Rubus, Malviviscus, Begonia, Ipomoea, Sida, Passiflora, Erythrina,* many Ferns, Bromeliads, Aroids, *Urticaceae,* Oaks, Melastomes and *Rubiaceae.*

The sub-alpine regions occur above 2500 m. and are cold, windy, and usually mist-enshrouded. Typical of such regions is the Volcan de Chiriqui near the Costa Rica border, rising to a height of almost 4000 m. Here on its steep slopes can be found most of the plants characteristic of the volcanic cones of Costa Rica, including such typical plants as Bamboo, *Weinmannia, Sisyrinchium, Hypericum, Alchemilla, Valeriana,* and many Ericaceous shrubs. This is surely one of the most beautiful and interesting regions of the tropics.

Besides endemic plants, there are many naturalized genera which have been introduced into Panama during its more than 400 years of history. Many of these can be found in regions which now are quite uninhabited, so thorough has been their naturalization. Among these are included *Cocos, Artocarpus, Mangifera, Garcinia, Annona* and *Carica,* and to a lesser extent *Musa, Hevea,* and *Coffea,* all of some economic importance. And the chances are that further importation of species from such places as the East Indies, the original home of the mangosteen, queen of tropical fruits, will continue through accident and for esthetic and economic reasons. Even now the United States Government is seeking available land for producing rubber on a large scale in the Americas, should the East Indian supply be cut off by war.

More thorough exploitation of other resources will also undoubtedly take place with the incorporation of better transportation facilities. Certainly there are many forest trees, which if accessible, would be of great commercial value. Much of the land is suitable for agriculture of some type: witness the great banana, coconut, cacao and abacá plantations of the lowlands. Yet today the Panama disease has driven the banana plantations from the Atlantic coast, and bud rot is playing havoc with the coconut. Perhaps even the highland regions may eventually feel the wrath of the coffee blight. But undoubtedly there are many tropical fruits and vegetables as yet not raised in quantity in the tropics, and not available in the temperate latitudes where a taste might easily be cultivated for mangosteen, zapote, mango, soursop, plantain, cherimoya, yam, etc. Many more market vegetables could undoubtedly be raised in Panama now, were proper agricultural methods followed. As yet there has been no nation-wide attempt at agricultural education, and perhaps the best truck-farmers of the country are still immigrant Chinese.

The history of Panama is as romantic as that of almost any other region in the New World. Starting with the conquering Spanish "conquistadores" in 1510, privateering and bloodshed were the order of the day for centuries. Then came the French failure and the American success with the canal, and finally an orderly democratic type of regulation now in force. The story of Panama is history itself, and details concerning it can be found in any adequate history book of the Americas.

The story of botanical collecting also has had a long history in this region. Among the earliest collectors were G. F. OVIEDO, who was in the region about 1520, J. WALLACE, doctor for the ill-fated Scottish settlement of New Caledonia near the Colombian border, who collected about 1700, and L. NÉE and T. HAENKE who were collecting together in South America as well as Panama about 1790. Later prominent collectors and naturalists of the 19th century include J. E. BILLBERG (about 1826), H. CUMING (about 1830), J. WARSCEWICZ (about 1840s), R. B. HINDS, G. BARCLAY and A. SINCLAIR (about 1840), B. C. SEEMANN (about 1847), H. H. BEHR (about 1848), A. FENDLER (about 1850), P. D. DUCHASSAING (about 1850), J. BALL (about 1852), S. HAYES (about 1860), C. E. O. KUNTZE (about 1874), J. H. HART (about 1885).

Modern collectors of the 20th century have been very numerous in Panama. Among them may be mentioned Brs. CÉLESTINE and GERVAISE, J. F. COWELL, M. E. DAVIDSON (Mrs. R. A. TERRY), M. A. HOWE, H. JOHANSEN, J. F. MACBRIDE, C. H. OSTENFELD, C. W. POWELL, F. L. STEVENS, and R. S. WILLIAMS.

In addition, collecting for the Smithsonian Institute within the last 30 years were E. D. CHRISTOPHERSON, E. A. GOLDMAN, A. S. HITCHCOCK, E. P. KILLIP, W. R. MAXON, H. PITTIER, C. V. PIPER, J. N. ROSE, and P. C. STANDLEY. Other collectors, collecting at present or within the last few years for the Missouri Botanical Garden, where a Flora of Panama is now in the process of compilation, are P. H. ALLEN, C. W. DODGE, A. A. HUNTER, R. W. SCHERY, R. J. SEIBERT, J. A. STEYERMARK, H. WEDEL, GENE WHITE, PEGGY WHITE, and R. E. WOODSON. Specimens of most of these collections can be found in almost any of the larger herbaria of the United States today.

For further information concerning the floristic aspects of Panama, one should refer to the following books:

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MISSOURI BOTANICAL GARDEN and WASHINGTON UNIV., ST. LOUIS, MO.

**FORREST SHREVE: The vegetation of Jamaica**:- Jamaica is the third largest of the West Indian islands, being 144 miles long and 30 to 40 miles broad. It is 100 miles south of Cuba, 120 miles west of Hispaniola and 380 miles northeast of the nearest point on the continent. The island is connected with the coast of Honduras by a shallow marine bank which has been suggested as a possible former bridge over which plants and animals reached the larger islands from the mainland.

It is possible that such a bridge may have existed at different periods in the Cenozoic, but nevertheless the flora of Jamaica has at present less relation to that of Honduras and Central America than the floras of any of the other large islands of the Antilles. The flora of Jamaica has a weak relation to that of Central America, has the highest percentage of endemics of any of the larger islands, and in general has little relation to the other Caribbean islands. It has been suggested that Jamaica was the first island separated from the Caribbean block. If this be true the fauna and flora of the other islands had little chance to immigrate across the temporary land bridge between Honduras and Jamaica.

The lack of relationship between the floras of Jamaica and the mainland, and the close relation of the floras of Cuba and Hispaniola with that of Honduras, constitute an unsolved problem.

The early settlement and natural wealth of Jamaica led to its reaching a high state of agricultural productivity at a time when the North American continent was still a wilderness. The flora consequently received early attention, the first by J. HARLOW in 1670, and by H. BARHAM, who was in the island from 1680 to 1726. Sir HANS SLOANE visited Jamaica from 1687 to 1689 and published the first record of the plants of the island in his "Natural History of Jamaica", which appeared in 7 volumes between 1707 and 1725. W. HOUSTOUN collected in Jamaica from 1729 to 1733, and PATRICK BROWNE made extensive explorations from 1746 to 1755, publishing his "History of Jamaica" in 1789. During the last half of the Eighteenth Century and the first half of the Nineteenth Jamaica was more frequently visited and more thoroughly explored than any of the other West Indian islands. Prominent collectors in this period were JACQUIN, WRIGHT, SWARTZ, MARTER, WILES, PURDIE, M'NAB, LUNAN and MACFADYEN. This period culminated in the appearance of GRISEBACH's Flora of the British West Indies (1850-1864), which was long the standard work on the West Indian flora.

In 1887 WILLIAM FAWCETT arrived in Jamaica, where he spent 21 years in connection with the Department of Agriculture. He did much collecting and was efficiently aided by WILLIAM HARRIS. In 1910 appeared the first volume of the "Flora of Jamaica", by FAWCETT and RENDLE. This has been followed by subsequent volumes, but completion of the work was terminated by the death of the senior author.

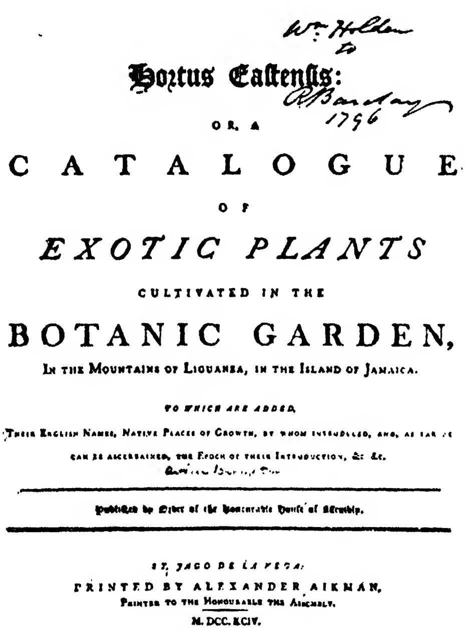
In spite of the long and active interest in the botanical exploration of this small island there are still several poorly known regions. The unsettled limestone area in the northwestern parishes has not been completely explored, and on the north face of the Blue Mountains there is an area of about 500 sq. mi. in which no botanist has set foot.

The character and distribution of the plant communities of Jamaica and their relation to the varied conditions have received little attention. In 1846 the Danish botanist ØRSTED visited the island and published a short paper entitled "Skildring af Naturen paa Jamaica," in which he gave an excellent outline of the vegetation in a strikingly modern manner. His paper is illustrated by a small map (in white lines on black background) showing the location of savanna, semi-desert and the types of forest. The coastal vegetation has been very briefly described by HARSHBERGER (Torreya 3:67, 1903). The higher Blue mountains were investigated by SHREVE (Carn. Inst. Wash. Pub. 199, 1914). Some information about the vegetation may be gleaned from the reports of collectors who visited the island at various times in the interests of the New York Botanical Garden (see Jour. N. Y. Bot. Gard. 1900-1920).

Both in vegetation and flora Jamaica is similar to Cuba and Hispaniola, the only larger islands of the West Indies. Like all mountainous islands in tropical latitudes there are moist warm lowlands, wet cool highlands, and dry hot lowlands, as well as grassy savannas. The close-set and rugged topography controls the local climates and results in striking differences

of vegetation in an island only 144 miles long.

The eastern end of Jamaica is 20 miles in width but supports the Blue Mountains, which form a continuous ridge of 5000 to 6000 ft. and culminate in Blue Mountain Peak at 7428 ft. The broader central and western sections of the island have a mountainous axis of lower elevation, the highest points of which are Mount Diablo and Bull Head. On the north the mountains fall gradually to the sea. On the south a narrow plain lies south of the Blue Mountains and a broader one extends from Kingston Harbor to the west end of the island. The narrow plain is relatively arid, while the broader one embraces marshes and savannas.


Hortus Eastensis:

OR, A

CATALOGUE

OF

EXOTIC PLANTS

CULTIVATED IN THE

BOTANIC GARDEN,

IN THE MOUNTAINS OF LIGUANEA, IN THE ISLAND OF JAMAICA.

TO WHICH ARE ADDED,

THEIR ENGLISH NAMES, NATIVE PLACES OF GROWTH, BY WHOM INTRODUCED, AND, AS FAR AS CAN BE ASCERTAINED, THE EPOCH OF THEIR INTRODUCTION, &c. &c.

Published by Order of the Honourable House of Assembly.

ST. JAGO DE LA VEGA:

PRINTED BY ALEXANDER AIKMAN,

PRINTER TO THE HONOURABLE THE ASSEMBLY.

M.DCC.XCIV.

Facsimile of the title page of the Catalogue of the *Hortus Castensis* (1794), one of the earliest botanical gardens in the Western Hemisphere. (*Courtesy Arnold Arboretum Library*)

The mountains of Jamaica lie athwart the trade winds, which assures a copious rainfall of 100 to 140 in. throughout the north side of the island. On the Blue Mountains the zone of maximum rainfall is apparently between 3500 and 5000 ft., corresponding with the lower limit of almost continuous daytime fog. The moist lowlands and lower mountain slopes support a heavy forest in which the composition is rich but not as rich as in the similarly situated forests on the mainland. Genera prominently represented among the trees are *Comocladia, Ternstroemia, Pithecolobium, Eugenia, Zanthoxylum, Piscidia, Lonchocarpus, Bauhinia, Calyptranthes, Miconia, Muntingia* and *Trichilia*.

The lowland forests suffer in comparison with those of the mainland in the average size of the trees. The largest individuals of *Ceiba, Cedrela* and other tall trees are localized or scattered and the canopy is irregular. The stature of the forest decreases with increasing altitude, largely because of the steep slopes and rapid erosion, which shorten the lives of most of the trees. At the lower edge of the fog belt a marked change in the forest takes place. The canopy is more uniform in its level but more open. Tree ferns become common, while palms, heliconias and lianes disappear. Ferns become very abundant on the floor of the forest and as climbers and epiphytes, and mosses hang from trees and shrubs, cover standing and fallen trunks, and carpet the loose stones. Gloom and dampness prevail during the long hours of fog and rain. The forest of the high mountains is relatively simple in composition, with *Clethra occidentalis, Vaccinium meridionale* and *Podocarpus Urbanii* as the commonest trees. Thickets of *Gleichenia* and *Davallia* fill the openings in the forest and the climbing bamboo *Chusquea abietifolia* binds the vegetation together in an impenetrable tangle. These conditions prevail to the summits of the highest peaks, with a noticeable lessening in the stature and density of the forest.

On the south face of the Blue Mountains the annual rainfall at 5000 ft. is about 100 in. and the amount of fog rapidly lessens with decreasing altitude. Immediately south of the main ridge the forest canopy becomes more open, tree ferns very local, epiphytic mosses and ferns far fewer, and tall shrubs more abundant. The forest is somewhat richer in tree species than it is on the north slope, including *Eugenia Marchiana, Cleyera theoides, Alchornea latifolia, Turpinia occidentalis, Xylosma nitidum, Trichilia havanensis, Cupanea glabra, Laplacea Haematoxylon, Miconia dodecandra, Guarea glabra* and many others. The only conifer is the infrequent *Juniperus barbadensis*. The shrubs are chiefly *Melastomaceae, Rubiaceae* or *Urticaceae*. Below 4500 ft. much land has been cleared in this region for cultivation of coffee.

The Liguanea Plain, which skirts the coast south of the Blue Mountains, is too dry for extensive cultivation and is mainly devoted to grazing. Parts of the plain appear to be still in a relatively natural condition. The vegetation is an open semi-arid forest in which *Bursera Simaruba, Haematoxylon campechianum, Piscidia piscipula, Prosopis juliflora* and *Acacia villosa* are now characteristic.

Along the south coast for 70 miles west from Kingston harbor is an intermittent strip of naked limestone which is the dryest area in Jamaica and the most xeric in its vegetation. The annual rainfall is probably about 25 to 30 in. (Kingston receives 32 in.), the percentage of sunshine is high, and the relative humidity is very constantly about 75% (see SHREVE, Plant World 13, no. 5, 1910). The aspect of the vegetation is very similar to that of the

southernmost continental deserts of Mexico. Open thorny shrubbery and several types of cacti dominate the landscape. The common plants are *Acacia Farnesiana, A. lutea, Guaiacum officinale, Brya ebenus, Leucaena glauca, Suriana maritima,* and the cacti *Cereus peruvianus* (= *C. Swartzii*), *Harrisia gracilis, Opuntia spinosissima* and *Melocactus communis.*

The level areas of the southern parishes are now largely devoted to the cultivation of sugar cane and bananas, the latter aided by irrigation. The original vegetation of the savannas was probably coarse sedges and grasses with few trees. In certain places the palm *Geonoma Swartzii* forms open forests. There are no native pines here or elsewhere in Jamaica and very few of the plants associated with pines in the province of Pinar del Rio, Cuba. The largest of the swamps in southwestern Jamaica is the Great Morass of Westmoreland, rich in aquatic and palustrine plants.

The limestone region of central and northwestern Jamaica is covered with steep, close-set hills separated by a network of narrow valleys. The slopes of the hills are still covered with an almost undisturbed thin forest. In the network of valleys there is some cultivation of coffee and pimento (allspice). Lime sinks are of frequent occurrence, their walls covered with mosses and delicate hygrophilous ferns, in strong contrast to the dry scrub of the nearby hills. Prominent among the many species of trees in this region are *Erythroxylon rotundifolium, E. obovatum, Pithecolobium arboreum, Ternstroemia granulata, Ceiba pentandra, Exothea paniculata, Calyptranthes chytraculia, Eugenia Fadyenii, Miconia macrophylla, Cassia grandis, Lonchocarpus latifolius, Piscidia piscipula, Zanthoxylum insulare, Amyris balsamifera, Trichilia moschata,* and *Malvaviscus Sagraeanus.*

A considerable but undetermined number of plants are endemic to Jamaica. There appears to be a larger number of them in the western end of the island than in any other district, and more of them in the low central mountains than in the higher and more recently uplifted Blue Mountains. There are a number of cases in which a genus is represented by one species in the central mountains and by another, filling the same ecological niche, in the Blue Mountains.

The varied climate of Jamaica has resulted in considerable diversification of its agriculture. The staple crops are sugar, bananas and coffee, but fiber plants, pineapples, pimento, cassava, ginger, oranges, yams and a large number of fruits and vegetables are produced in small quantities. For more than a century there has been constant private and governmental experimentation with new economic plants or new strains of the staples. Much of the early work of this character was located at Bath, in the southeast, where a botanical garden was built up and maintained for many years. Late in the 19th Century the cultivation of cinchona, or quinine bark, was attemped in the Blue Mountains and the headquarters of the Agricultural Department were moved to that region. Economic conditions frustrated this otherwise successful venture and the Department was again moved to the lowlands and located at Hope, near Kingston. The mountain location had been developed as a small botanical garden devoted to the display of temperate plants, and was long maintained for scientific work and as a recreation spot for the officials of the island. The Hope Gardens now afford a large display of tropical economic and ornamental plants, and also accommodate nurseries and experimental grounds. The nearby grounds at King's House, residence of the Governor, also contain an interesting array of native and exotic plants. In a warm moist location in the low hills north of Kingston the Government maintains the Castleton Gardens. The experimental work in this favored spot has resulted in the introduction of several East Indian economic plants. There is a fine display of ornamentals from the tropics of all parts of the world and a notable collection of over 300 species of palms.

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A. DUGAND: **On the Vegetation and Plant Resources of Colombia**:- The Republic of Colombia, located in the northwestern corner of South America, has extensive coasts on both the Atlantic and Pacific Oceans, being the only country south of Panama enjoying such a geographical advantage. Its seaports are at shorter distances from New York, New Orleans and San Francisco than any others in South America. With an area of 1,139,155 square kilometers (439,828 sq. miles), it is the fifth largest country in that continent, and the third in population, which is officially estimated at 9,167,800 for 1941, or about 8 inhabitants to the square kilometer (20.7 per sq. mile). Considering, however, that 96.6% of the population is settled in the western and northern parts of the country, in an area comprising only two-fifths of the whole territory, the relative density of the inhabited part is increased to 19.5 per square kilometer (50.5 per sq. mile), the remaining three-fifths being almost uninhabited.

In the botanical bibliography, the country is often referred to as "New Granada", which was its official name during part of the nineteenth century, before the name Colombia was definitively adopted.

Lying within 12°30′ north and 4°13′ south of the Equator, from the Caribbean Sea to the Amazon River, the climate is tropical over the greater part of Colombia, but the country is crossed by three lofty and distinct ranges of the Andean Cordillera, separated from each other by large valleys descending to the torrid zone, and causing considerable diversity in climate conditions according to elevation, with a corresponding variation in the vegetation.

The coastal lowlands up to an altitude of 350 meters, and the immense plains of

the Orinoco and Amazon basins as well as the low-lying valleys of the interior to about 500 meters above the sea are hot (mean temperature ranging from 27° to 30°C.); the highlands to an altitude of 1000 meters are warm (mean temp. 23° to 26°C.). From this elevation to about 1500 meters the climate is mild (mean temp. 20° to 22°C.), then more temperate to 2000 meters (17°-19°C.), cool to 2500 meters (14°-16°C.) and gradually colder above this level, reaching freezing point at some 4500-4800 meters, this being approximately the lower limit of the perpetual snow on the highest mountains.

It is estimated that 70.5% of the Colombian territory lies between sea level and 1000 meters; 15.8% between 1000 and 2000 m.; 10.5% between 2000 and 3000 m.; 2.6% between 3000 and 4000 m. and 0.6% above 4000 m.

From the influence of mean temperature alone, in relation to altitude, the vegetation of Colombia is divisible into four general vegetative "storeys": Megathermophytia, Macro-mesothermophytia, Micro-mesothermophytia and Microthermophytia (or Psycrophytia), the altitudinal boundaries of each being primarily isothermal but varying much according to local conditions (humidity, slope-exposure, open or inclosed character of the valleys, prevailing air currents and nature of the soil). These storeys do not necessarily correspond to the purely arbitrary and subjective division of climate given in a foregoing paragraph.

Broadly speaking, and ignoring individual exceptions, megatherm plants thrive between sea-level and an upper limit varying from 800 to 1400 meters; they are insensibly followed by macro-mesothermophytes, the upper boundary of which lies between 2500 and 2800 meters; micro-mesothermophilous vegetation is found thereon to 3200-3800 meters, this level coinciding in humid districts with timber-line, and the psycrophytes occupy the following storey, their volume decreasing as altitude exceeds the 4200-meter level, while most of the upper frigid belt, below the snow-line, is rocky and devoid of vegetation.

The temperature of any given locality in Colombia shows comparatively small fluctuations throughout the year, rarely exceeding 8°C. above and below the mean except in certain arid and deforested districts, and the seasons are marked, not by increase of cold or heat, but by rainfall. Three types of seasonal distribution of rain can be distinguished: (1) a wet season of six to nine months duration and a distinct dry season of corresponding length; (2) two wet seasons of about three months each alternating with two either dry or at least considerably less rainy periods of equal duration; and (3) one wet season lasting almost the year round, with no well-defined dry period. North of latitude 8°N. the seasons are characterized by the first type, and south of same latitude the second type is the rule, while the third is confined to the regions lying west of the Western Cordillera, in the Atrato and Pacific watersheds.

Average annual precipitation exhibits an enormous range of variation, but in its effect upon plant life it is distribution plus frequency of rainy days, rather than quantity, that cause wide differences in the character of the vegetation in each climatic storey throughout the country. The Guajira Peninsula, for example, has a long period of extreme drought and an annual rainfall of 300 to 800 millimeters in only 18 to 56 rainy days. Accordingly, the vegetation is quite xerophilous, consisting of small-leaved and thorny Mimosa-like shrubs, many cacti, bromeliads, and a scanty growth of stunted deciduous trees. Large stretches of land, swept by the trade winds during the dry season, are almost barren, sun-baked, and bear the appearance of deserts.

On the other extreme, the Pacific Coast affords a decided contrast. This region is subject to one of the most abundant rainfalls in the world; there is no dry season, and it rains almost daily, the annual precipitation often exceeding 5000 mm., and the frequency ranging from 167 to 303 days. Years with more than 8500 mm. have often been recorded. The dominant vegetation is of the dense, luxuriant, hygrophilous or "rain" type of forest with tall trees and a profusion of creepers, parasitic and epiphytic growth. There are palms of many kinds, and the shady moist forest-floor is overgrown with broad-leaved plants mostly of the scitamineous and cyclanthaceous families. Similar humid conditions prevail over the central portion of the Magdalena watershed, as well as on the lower ridges of the Eastern Cordillera from the Putumayo basin to the Catatumbo watershed, and in the Amazon basin south of the Guaviare River, although the rainfall is not so high (1500 to 6000 mm. in 136-295 days), and there are distinct periods of minimum precipitation.

In the Eastern Llanos, lying north of the Guaviare River, from the base of the Eastern Andes over the huge level plains drained by the tributaries of the Orinoco, rainfall is still considerable but unevenly distributed (1200-5600 mm. in 70-241 days) and it is interrupted twice a year by periods of greatly reduced precipitation, one of which is quite dry. The predominating vegetation is sub-xerophilous, consisting for the most part of immense grassy savannas dotted with palms and scattered shrubs. Islands of dense jungle and groves of *Mauritia*-palms occur only in humid bottomlands but the immediate vicinity of the rivers is overgrown with frondose sub-hygrophilous forests of the "gallery" type which fringe the banks and extend from a few yards to many miles on each side depending upon the local conditions of the soil in relation to the amount of water of infiltration available.

The Caribbean coastal plain, stretching from the Sinú River to the lower Magdalena and upper Cesare valleys has a very irregular and unevenly distributed rainfall averaging from 300 to 4350 mm. in 22-145 days, with one annual period of utter drought lasting from three to five months. The country is level or moderately hilly and rolling, generally semi-arid and open, partly marshy along the rivers, and covered with a vegetation of shrubby trees and clambering vines growing in thickets, and

scattered groves of short-boled deciduous trees. It is not much forested except in the vicinity of streams and in protected hill-slopes or bottomlands, and large areas consist of grassy savannas. According to local rainfall and soil conditions, the forest growth shows every gradation from the scrubby and deciduous xerophytic type to the perennially verdant subhygrophilous forest with medium-sized to large straight-boled trees and dense undergrowth. Over large stretches they are of the transition or tropophytic type, assuming the appearance of the true humid forests during the rainy season, but resembling the dry forests during the drought period, when most of the species shed their leaves and the herbs wither or die.

Subxerophilous vegetation, not unlike the above noted, prevails in the upper Magdalena valley, south of Honda, in the Cúcuta lowlands near the Venezuelan border, and in the floor of the Cauca valley.

Mountainous districts in the more thickly populated sections of central Andean Colombia were probably covered once with luxuriant subtropical and temperate forests to an elevation of about 2700 meters and though large patches of dense primitive woodland are still found nowadays, most was destroyed long ago or is being gradually cleared for agricultural purposes, of which coffee-growing, cattle-raising, other agricultural activities and charcoal-making are the chief responsible factors, with timber-exploitation coming only fifth. As a result of widespread deforestation, erosion is gaining ground in rugged slopes, especially in the provinces of Santander and Norte-Santander, while the exhaustive and random methods of farming the rolling lands are impairing somewhat the usefulness of many regions for either agricultural or forest production.

The "Coffee Belt" occupies the lower portion of the temperate storey and the modality of its cultivation, inherent to its shade-loving quality, compensates in part for the loss of original arboreal mass in such districts.

The upper macro-mesothermic and the micro-mesothermic storeys are characterized usually by a great humidity resulting from the mist that prevails almost daily at this elevation, due to the condensation of the warm moisture-laden air currents rising from the hot valleys below and meeting the cold air in the upper regions. As a natural consequence, the forests are of the hygrophilous type, composed of sturdy, medium-sized trees set close together over a thickly-branched underbrush in which climbing *Chusquea*-bamboos are prominent; they differ, however, very markedly from the humid megathermophilous forests in constituent species, genera and even botanical families. Tree limbs are generally clothed with epiphytes, mostly orchids and mosses, and there is an abundance of ferns, some of these tree-like and reaching a height of six meters. Above 2700 meters the tree growth is dwarfed and the arid districts are bush-grown or treeless.

The microthermic or psycrophytic storey, above timber line, bears the influence of a very low mean temperature, though other factors such as soil acidity, strong winds and intense solar radiation act to make the vegetation of the upper Andean regions very strikingly xeromorphous, in spite of the humid conditions resulting from the frequent mists and the wet soil. The plants of the "Páramo zone", as this vegetative storey is often called, are generally prostrate or very low, and many are built like a rosette or are closely branched and cushion-like; a large majority are densely wooly, and the leaves are stiff and leathery. The vegetation of the open valleys and exposed mountain ridges is composed of tough, fascicular grasses interspersed with clumps of *Espeletia* and other thick-leaved Compositae, while in the deep ravines there are thick bushes and stunted treelets generally covered with mosses and lichens.

Notwithstanding the progress made by Colombia in the last twenty years in the industrial field, it remains essentially an agricultural country, depending mainly on the exportation of vegetable products (74%) for the maintenance of its commercial balance with the outside world, the other exports consisting principally of petroleum, hides, gold and platinum. Coffee is by a very wide margin (65%) the staple commodity upon which Colombian export commerce rests (over 4,000,000 bags of 60 kilograms annually) and its fluctuations reflect deeply on the whole economic structure of the country. The mechanical industries still have only a minor though growing local importance and most of them are exclusively based on the working or transformation of raw materials yielded by the vegetable kingdom, such as: cigar and cigarette manufacture, alcohol-distilling, cotton-weaving, beer-brewing, flour-milling, sugar-refining, chocolate-making, coffee-roasting, the making of vegetable lard and oil, the weaving of rayon silk, the working of sacks and ropes and the sawmill industry. However, Colombia does not yet produce all the materials it needs, except for the tobacco, coffee-roasting, alcohol, sack, and sawmill industries, and must therefore complement the supply by importing a large share (about 26%), especially cotton, coprah, cellulose, wheat, malt, hops, cocoa and rice.

Other plant products exported by Colombia, besides coffee, include: bananas, the bulk of which is consumed in the United States; perillo-gum produced by a species of *Manilkara*, which is used with chicle (*Achras Sapota* L.) in the making of chewing gum; dividivi pods (*Libidibia coriaria* Schl.) used in tannery; balsam of Tolú, produced by a leguminous tree (*Myroxylon balsamum* Harms) used as a medicine to relieve coughing; tagua nuts from three or four species of ivory-palms (*Phytelephas*) used in button manufacture, and the so called "Panama hats" made from the fiber of a palm-like plant (*Carludovica palmata* R. & P.). Tobacco exports, being almost totally directed towards Europe, have considerably dropped due to the war.

The crops grown in Colombia for local consumption are chiefly foodstuffs: yuca (*Manihot dulcis* Pax), corn, rice, cocoa, plantain, sugarcane, beans, peas and sesame in the megathermic and part of the mesothermic belts; the only products with a distinct use being tobacco and cotton, though the seeds of the latter are used for extracting edible oil. The micro-mesothermic and the lower portion of the microthermic belts produce wheat, potatoes, barley, oats, maize and a mealy tuber locally known as arracacha (*Arracaccia xanthorrhiza* Bauer). A semi-cultivated plant of the Amaryllis Family called fique (*Furcraea gigantea* Vent.) thrives well in arid and rocky soil and is the principal source of the fiber used in sack-making. Vegetables and fruits of many kinds are cultivated in all but the frigid belts and large areas are devoted to pastures.

The timbers used for general construction, carpentry and cabinet-work differ according to the regions. Over 200 different vernacular names have been recorded so far, but many apply to the same botanical species or, otherwise, one same local name is used for distinct kinds of wood. Only partial botanical surveys have been made heretofore to identify the species. In the Caribbean districts as far south as the central Magdalena valley the best known useful timbers are: abarco (*Cariniana pyriformis* Miers), ceiba colorada or ceiba tolú (*Bombacopsis quinata* Dugand), carreto (*Aspidosperma Dugandii* Standl. and *A. Curranii* Standl.), cativo (*Prioria copaifera* Griseb.), cedro (*Cedrela mexicana* Roem. and *C. fissilis* Vell.), caoba (*Swietenia macrophylla* King), masábalo (*Carapa guianensis* Aubl.), roble or ocobo (*Tabebuia pentaphylla* Nichols.), canalete or solera (*Cordia alliodora* Cham. and *C. gerascanthoides* HBK.).

In central Colombia: pino hayuelo or chaquiro (*Podocarpus taxifolia* HBK.), pino romerón (*Podocarpus macrostachya* Parl.), nogal (*Juglans columbiensis* Dode), roble (*Quercus granatensis* H. & B. and other species of the same genus), comino, chachajo (*Aniba perutilis* Hemsl.), cedro (*Cedrela bogotensis* Tr. & Pl. and *C. montana* Turcz.), piñon or carito (*Enterolobium cyclocarpum* Griseb.), caoba (unidentified, probably a species of *Cedrela* or *Swietenia*). Other useful woods are: diomate or quebracho (*Astronium graveolens* Jacq.), dinde, palomora (*Chlorophora tinctoria* Gaudich.), jigua, laurel (*Ocotea* spp.), aceite, palo maría (*Calophyllum Mariae* Tr. & Pl.), guayacán jobo (*Centrolobium* sp.), chicalá, cañaguate, guayacán polvillo, coralibe (*Tabebuia spectabilis* Pl. & Lind., *T. chrysantha* Nichols., *T. Billbergii* Standl.).

Since present world conditions call for a pooling of Pan-American resources and are favorable for the production of vital vegetable commodities especially in the Amer. tropics, Colombia emerges as one of the countries in which well-directed cultivation is bound to result in important mutual benefit to continental solidarity and self-sufficiency. Its privileged geographical situation, as pointed out at the beginning of this article, makes it stand out as one of the most promising lands for agricultural development.

The rugged character of the country has hindered transportation for many years, partly retarding the development of natural resources; there are, however, at present 10,800 kilometers of highways, 3200 km. of railways and over 8500 km. of navigable waterways, of which 2900 have a direct access from the Pacific and Atlantic coasts. Building of important motor roads is proceeding at a fast pace.

The humid belt of the Pacific and Atrato watersheds, lying near the Panama Canal and having easy outlets on both Oceans, as well as the central Magdalena valley directly accessible from the Caribbean Sea, are very well suited for the extensive planting of *Hevea brasiliensis*, the world's most important rubber-producing tree; the same regions are adequate for the growing of the Balsa tree (*Ochroma pyramidale* Cav.) and rotenone and other insecticide-producing plants (*Lonchocarpus Nicou* DC. and *Tephrosia toxicaria* Pers.). A number of fast-growing trees with high cellulose content (species of *Cecropia*, *Schizolobium*, *Didimopanax*, *Cochlospermum*) and *Guadua*-bamboos thrive naturally in many parts of tropical Colombia, the Cecropiae and bamboos forming extensive mixed stands in the central and lower Magdalena valley, respectively. Large areas of humid forest-floor are densely covered with pita (*Aechmea magdalenae* (André) André), the leaves of which produce one of the best and toughest fibers known.

The Sub-Andean belt which was once known as the "Cinchona Zone", for here grow naturally many of the original species producing the cinchona-bark from which quinine is made, is indicated for the propagation of the best varieties of this useful tree. *Eucalyptus globulus*, from the leaves of which eucalyptus-oil is distilled, is extensively planted as ornament and for reforestation purposes in the middle Andean belt, but it is not exploited commercially.

The Eastern Llanos are the natural habitat of the tacay (*Caryodendron orinocense* Karst.), the seeds of which yield a high-grade oil, and of the chiquichique (*Leopoldinia Piassaba* Wallace), a palm from which the well-known Piassaba-fibre of commerce is obtained. Sarrapia trees (*Coumarouna*), the source of the tonka-beans used in the perfume industry, grow in the same region.

A shrub producing wax of excellent quality (*Myrica pubescens* Willd.) grows abundantly in the cool Andean belt. The same region is the home of the famous Andean wax-palms (*Ceroxylon quindiuense* Wendl. and other species of *Ceroxylon*) but the relative scarcity of these palms as well as the difficulty inherent to collecting the wax coating the slender and very lofty trunks that reach a height of sixty meters, should remove them from the economic point of view.

Pending the building of special machines capable of breaking the thick, hard shell of many kinds of palm-nuts without damaging the seeds from which edible oil is extracted, the extensive natural palm formations are awaiting exploitation on a large scale in Colombia. Quite the largest part of the raw material used in the local vegetable lard and oil factories is still imported. A few palms are now being ex-

ploited in a small scale in the lower Magdalena valley and the Caribbean coast; these are: palma de vino (*Scheelea exselsa* Karst. vel aff.), nolí (*Corozo oleifera* Bailey), mangué (*Attalea nucifera* Karst.), mamarrón (*Attalea* sp.) and tamaca (*Acrocomia* sp.).

A medicinal oil extracted from the crushed and boiled kernels of the Unamo palm (*Jessenia polycarpa* Karst.) that grows in the Eastern Llanos and southern Colombia, is being experimented with and may prove successful against pulmonary tuberculosis, according to recent reports. A dark brownish fatty substance obtained by boiling the crushed fleshy mesocary of a palm-fruit (*Corozo oleifera* Bailey) is considered to be a remedy for dandruff and is also widely used as a scalp tonic alleged to prevent the hair from falling or turning grey.

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**LLEWELYN WILLIAMS: Natural Resources of Venezuela:-** Situated within the torrid zone, with altitudes ranging from sea-level to mountain ranges and peaks elevating to 16,000 feet, Venezuela enjoys almost every type of climate, admirably suited for the growth of a wide variety of plants. Of its total area of about 600,000 square miles, it is computed that more than 50% is covered by forests, 44% by savannas and paramos, whereas the area under permanent cultivation amounts to less than 1%, concentrated mostly in the Andes and the valleys of the Coastal range.

Leading the parade of agricultural commodities is *coffee*, which ranks as the principal cash crop, the main plantations being located along the slopes of the littoral. Formerly attention was given to developing suitable varieties, but in recent years, as elsewhere in tropical America, efforts have been in the direction of supporting prices. The grades of coffee are classified roughly according to the altitudes at which grown. Thus the product of the *tierra caliente* is distinguished by its large yellowish bean, that of the temperate region is also of light color, while coffee grown in the cold area has a smaller, yellowish gray bean, of better quality and contains a higher percentage of caffeine. It is generally believed that *cacao* is indigenous to Venezuela and that belief is attested by the *cacaotales* still encountered in the forests of the Orinoco basin. Two species are distinguished, namely, *Theobroma leiocarpa*, "the cacao trinitario" of inferior grade, and the better known *Th. Cacao*, "cacao criollo" or "cacao dulce", which, at one time, was the sole species cultivated in the central and western parts of the country and furnished the famed "cacao de Chuao" and of Maracaibo. The introduction of strains from outside has resulted in the development of a number of varieties of poorer quality, so that the pure criollo type is now grown only at Caruao, Puerto La Cruz, Costa de Maya and other limited areas along the north coast. *Corn* may well be considered the oldest of all cereals, having formed the staple food of the people of the Cordilleras, as in other parts of the American Continent, since remote times. Today numerous varieties, augmented by strains from temperate countries, are cultivated throughout the Republic. *Wheat*, first planted by the early colonists, was grown at one time throughout the northern region in sufficient quantity to meet the entire domestic demand. The development of commercial intercourse between Venezuela, Europe and the United States, towards the middle of the last century, was a severe blow to the wheat districts of Aragua, Miranda, Carabobo and other areas adjacent to the principal ports. This situation was further aggravated by the increasing interest in the cultivation of cacao, later superseded by coffee. At present wheat is grown only on an insignificant scale in the remote valleys and mesetas of the Andes, far removed from the populated centers, but the impulse recently given by the government, through the establishment of mills in the state of Trujillo, should lead to an increased production. *Rice* has been grown successfully in the northern districts of the Llanos, along the foothills of the Andes, at Barlovento along the coast, as well as in the lower Caura and at El Palmar, in eastern Guiana, but the present yield is sufficient to meet only a mere fraction of the large domestic consumption. Of *beans*, which form an important element of the peasants' diet and generally known in the vernacular as "caraotas", the principal cultivated species are *Phaseolus vulgaris*, of which the black variety, "caraota negra", is the better known, *Ph. lunatus*, called "guaracaro", and *Ph. multiflorus*. *Potatoes* flourish in the Andes at altitudes up to 10,000 feet, and especially in the meseta of Bistites, in the State of Trujillo, while successful crops have been produced in the last few years in the colony of Chirgua, in the valley of Ocumare del Tuy and at Baruta, near Caracas. *Tobacco* is considered to be indigenous to Venezuela and certain classes have attained local fame, such as "barinas" during the Colonial period, and the "guácharo", "chimo" and "capadare" now esteemed throughout the country. The

bitter *cassava* (*Manihot utilissima*), of which there are several varieties, is grown in small patches, "conucos", throughout the eastern and southern parts, its distribution apparently coinciding with the migrations of the Carib Indians, while the sweet cassava (*M. Aipi*) is the species most frequently planted in the central and western parts. *Sugar cane* is grown, almost to the exclusion of other crops, in the valley of Aragua, at Guarenas and other districts in the north central region. Successful results have been obtained in the last few years with the cultivation of *cotton* in the vicinity of Lake Valencia, for the local market, and of *bananas* in the eastern part of the State of Yaracuy for export. The usual tropical fruits are grown throughout the country although only on a small scale to meet the limited local demand.

The experimental stations established by the government during the last five years in various parts of the country actively pursue investigations relative to the cultivation of cotton, bananas, grasses for forage and other important agricultural crops, also in conducting propagation experiments with introduced plants, such as sesame, soybeans, peanuts, tung oil trees, etc. which may prove profitable as new crops. Facilities for research in plant diseases, genetics, soil analysis and insect pests are provided at the School of Agriculture and Zoology at Sosa, near Caracas, the members of its staff also serving in an advisory capacity on local problems. A comprehensive course in agriculture and related subjects is given to selected students at this institute as well as at the experimental station near Maracay.

Although the extensive forests of Venezuela have long been known to contain a large variety of useful timbers and other products of economic value, their remoteness from populated centers and principal ports, coupled with the lack of adequate transportation facilities, are not conducive to their exploitation on an appreciable scale. The most accessible region is that of Portuguesa and Barinas, in the western region, where logging is limited to mahogany, cedar, apamate, saquisaqui and a few other woods. Usually the logs are hauled overland to Acarigua, where they are sawed into lumber to be sold in the local markets. Up to the outbreak of the last World War the Maracaibo region was a valuable source of West Indian boxwood, vera, partridge wood, roble colorado and dyewoods, such as brasileto and fustic, exported to Europe and to a lesser extent to the United States. Since the entrance to Lake Maracaibo is not sufficiently deep for ocean-going steamers, the logs have to be transported in vessels with shallow draught to Curaçao for trans-shipment to the foreign markets. The swampy shores of Lake Maracaibo and the Delta Amacuro are favorable for the growth of mangrove tree, esteemed for its bark employed for tanning. Unfortunately, extensive formations of this useful species have been seriously depleted through the local use of its wood for house construction, fence posts and firewood. The rain forests of the Guiana contain many valuable timbers, but most of these are still little known and will probably remain untouched for some time. In this region, as elsewhere in the Republic, the widespread habit among the peasants of periodically cutting down and burning patches of virgin forest for temporary cultivation of yuca, rice, corn, etc., has resulted in the destruction of useful woods and other products, as well as introducing problems of decreasing soil fertility and erosion. In the restricted forests of the Delta Amacuro, where there is a heavy rainfall almost throughout the year, the vegetation is dense, difficult to penetrate and many of the trees attain enormous proportions. Among these may be mentioned "carapa" (*Carapa guianensis*), "mora" (*Dimorphandra Mora*), "viruviru" or "greenheart" (*Nectandra Rodiei*), as well as a number of latex-yielding trees. In the flood-free forests along the foothills of the Imataca range abounds the "cuspa" (*Cusparia trifoliata*), its bitter bark formerly exported through Ciudad Bolívar for use as an ingredient of Angostura bitters. The middle Orinoco is known best as the zone of the "tonka-bean" or "sarrapia" (*Coumarouna*), the center of production being the wooded slopes of the Caura and Cuchivero basins. The bulk of the crop is shipped to the United States, where it is utilized for imparting aroma to tobacco and in the manufacture of culinary flavors. In the remote Territory Amazonas, embracing the headwaters of the Orinoco and the Guainia basin, or upper Río Negro, as far as the Brazilian frontier, the forest is likewise dense and tall. With the exception of the banks of the main stream, the Casiquiare, or following the Atabapo river and overland from Pimichin to the Guainia river, this entire region has not been studied botanically and the composition of the forest is still poorly known. Plant products of economic value known to exist in this region include rubber, furnished by various species of *Hevea* and formerly exploited on a considerable scale; also "chiquichique" or "piasaba", a fiber yielded by a palm, *Leopoldinia Piassaba*, and still exported in considerable quantities by way of the Río Negro and Brazil in preference to the long haul down the Orinoco, made costly and difficult by the many rapids, especially those of Atures, which have to be negotiated. In the forests and savannas grow other species of palms, important as source of fiber and oils, among which may be mentioned the "moriche" (*Mauritia*), "seje" (*Oenocarpus*), "coroba" (*Scheelea*) and "macanilla" (*Bactris*). Other products of the Venezuelan forests worthy of mention are: "dividive" (*Libidibia Coriaria*), its pods employed for tanning, chicle (*Achras*), balata (*Manilkara*), species of *Couma*, furnishing a substance similar to gutta-percha, balsam of copaiba (*Copaifera officinalis* and related species), "barbasco" (*Lonchocarpus*), a plant poison now in demand for the manufacture of insecticides, medicinal barks such as those of "quina" (*Cinchona*) and "simaruba" (*Simaruba*

*amara*), also "guayacán" (*Guajacum officinale*), "gateado" (*Astronium graveolens*), the so-called West Indian sandalwood (*Amyris balsamifera*), "cartán" (*Centrolobium orinocense*), "palo de oro" (*Piratinera guianensis*), "pilón" (*Andira*), "acapro" (*Tecoma*) and a host of other valuable woods.

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**A. C. SMITH: The Vegetation of the Guianas, a Brief Review**:- The three Guianas, Brit., Dutch, and French, with a total area of about 180,000 sq. mi., are floristically closely related to n. Brazil and eastern Venezuela. The three colonies are essentially similar in topography, climate, and vegetation, although in the latter feature they appear to increase in diversity from east to west. The Guianas are drained by several large northward flowing rivers, which cut through an extensive area of slightly elevated igneous rock culminating in a low east-west mountain range on the Brazilian border. The highest elevation is found in Mount Roraima (2644 m.), at the juncture of British Guiana, Venezuela, and Brazil.

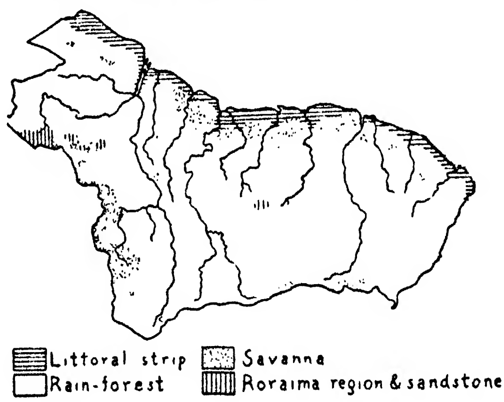
On the whole, temperature is remarkably equal throughout the year, varying near the coast from an average minimum of about 21° to an average maximum of about 32° Centigrade. At higher elevations in the interior the temperature is substantially lower.

The rainfall is caused by the damp northeast tradewinds coming from the sea; on the coast it averages between 2000 and 3000 mm. annually and is fairly well distributed throughout the year. However, two maxima and two minima are generally discernible. The major wet period occurs in May and June and the minor wet period in December and January; the major dry period occurs in September and October and the minor dry period in Februarv and March, although in some years the latter is hardly apparent. In the forested interior these seasons are often less marked than on the coast, and in the southern portion of the country, due perhaps to the influence of ranges of hills lying across the wind, there are generally only two conspicuous periods — a wet one from April to August and a comparatively dry one during the other months. On the interior savannas a rainy period is to be expected from about May to August, while during the other months rains are infrequent.

Four primary vegetational zones are obvious in the Guianas:- (1) the littoral strip, (2) the rain-forest, (3) the savannas (upland and swamp), and (4) the region adjacent to Mount Roraima.

(1) *The littoral part* of the Guianas is formed by an alluvial strip of land which varies in width from 10 to 30 miles or up to 60 miles along the larger rivers. Nearly bare mudbanks extend far into the sea, and on their landward side these banks are covered by typical mangrove vegetation, consisting chiefly of *Rhizophora Mangle*, *Avicennia nitida*, *Conocarpus erectus*, *Bucida Buceras*, and *Laguncularia racemosa*, sometimes with extensive developments of *Acrostichum aureum*, *Eleocharis geniculata*, and *Cyperus* spp. Farther inland, this coastal strip was originally covered with swamp forest and some swamp savanna, but it is now largely under cultivation and contains the major part of the human population and all the larger towns. The chief crops are sugar cane and rice.

(2) *A rain-forest*, typically Amazonian in appearance, covers 90 percent or more of the surface of the Guianas, ascending to the summits of the interior hills, which reach an elevation of 1000-1300 m.; among such ranges are the Kanuku and Akarai Mountains in British Guiana, the Wilhelmina Mountains in Surinam and the Tumuc-Humac Mountains in Surinam and French Guiana. The first falls of the large rivers are very near the coast, and on the partially submerged rocks of the river-beds are found many representatives of the *Podostemonaceae*; *Mourera fluviatilis* is the most conspicuous of these, and among other genera are *Oenone*, *Apinagia*, and *Lophogyne*.




THE VEGETATION OF THE GUIANAS

On sometimes flooded banks of sand and silt are to be found species of *Cyperaceae*, *Solanum*, *Heliotropium*, *Phyllanthus*, *Conobea*, *Jussieua*, *Psidium*, and *Turnera*, while on muddy banks the conspicuous aroid *Montrichardia arborescens* is usually present. The riverine rain-forest, especially near the coast, is rich in lianas which hide its true character; these belong especially to the *Convolvulaceae*, *Bignoniaceae*, *Vitaceae*, *Sapindaceae*, *Leguminosae*, *Combretaceae*, and *Marcgraviaceae*, and most conspicuous among them may be mentioned *Ipomoea fastigiata*, *Cydista aequinoctialis*, *Paragonia pyramidata*, *Cissus* spp., *Norantea guianensis*, and *Combretum* spp. Dense stands of *Cecropia* spp. are occasionally found along the rivers, as are numerous

species of palms of such genera as *Astrocaryum*, *Euterpe*, *Bactris*, and *Manicaria*. Conspicuous trees near rivers are *Ceiba pentandra*, *Pachira aquatica*, *Mora excelsa*, *Triplaris surinamensis*, and *Vochysia tetraphylla*.

While a casual traveler would consider this rain-forest to be monotonous and without definite types, actually it is by no means floristically homogeneous. DAVIS and RICHARDS (Jour. Ecol. 21:350/384, 1933; 22:106/155, 1934), in studying an area close to the lower Essequibo, were able to recognize a graded series of five types:

(a) The mora consociation has as its dominant *Mora excelsa*, as subdominants *Pterocarpus officinalis*, *Pentaclethra macroloba*, and *Aldina insignis*, with a tall herb layer of *Rapatea*, *Monotagma*, *Carludovica*, and *Pariana*. About 60 percent of the large trees are legumes. This type forms strips along streams on low ground which is subject to flooding, and the trees are usually conspicuously buttressed.

(b) The morabukea consociation has as its dominant *Mora Gonggrijpii*, and as subdominants species of *Eschweilera*, *Catostemma*, *Pentaclethra*, *Ocotea*, and *Licania*. This is the darkest type of forest and is found on the lower slopes of small flat-topped hills, on soil which is well-drained and not subject to floods; it covers large areas in the near interior and has its trees somewhat less buttressed than those of the mora consociation.

(c) The mixed forest consociation has no single dominant, but among the many species which are co-dominant are *Pentaclethra macroloba*, *Licania venosa* and spp., *Eschweilera Sagotiana*, and *Ocotea Rodioei*; *Lecythidaceae* are abundant. This type has a wide distribution and is chosen by the Indians for cultivation. The trees are frequently but not heavily buttressed. Although all of the consociations here mentioned are climax types, in that they do not belong to a secondary succession, the mixed forest appears to be the climatic climax of the district.

(d) The greenheart consociation has as its dominant *Ocotea Rodioei*, and as subdominants some of the species listed above for the mixed forest; there are here about 90 subsidiary species of canopy trees. This type occurs on sandy soil on the slopes of steep ridges and is very local in distribution, perhaps not occurring outside of British Guiana. The trees are only slightly buttressed.

(e) The wallaba consociation has as its dominant *Eperua falcata*, and as subdominants *Catostemma fragrans* and *Licania buxifolia*; the undergrowth trees are numerous and dense. This type occurs on white sand of hill ridges and is widely distributed near the coast and probably in the interior. The trees are not large and are hardly or not at all buttressed.

Although exact types of rain-forest vegetation such as those above described do not occur throughout the Guianas, somewhat similar consociations are recognizable. In the southern part of British Guiana, and presumably also in the south of the other two colonies, the forests are of a rather uniform mixed type, drier than the morabukea, greenheart, or mixed forest types nearer the coast. There are a greater number of predominant trees and many species with deciduous leaves (especially in the *Leguminosae* and *Bignoniaceae*), while the mimosaceous type of leaf is common. The floristic elements of this interior forest differ from those of the forest nearer the coast, the *Leguminosae*, *Sapotaceae*, *Rosaceae*, and *Lecythidaceae* being abundant. Many important endemic species of the northern forest (*e.g. Ocotea Rodioei*, *Mora* spp.) do not extend into this southern area, while some Amazonian species (*e.g. Bertholletia excelsa*) here have their northern limits. The forests of this region thus appear to be pre-climaxes of the Amazonian rather than the Guiana rain-forest.

Isolated forested hills, such as the Kanuku Mountains, bear up to their summits the same generic elements as the lowland rain-forest, but many species appear to be endemic to higher elevations. On rocky ledges of these hills are found numerous pteridophytes, including *Anemia tomentosa*, *Doryopteris palmata*, and *Selaginella* spp., while the forest itself is richer in undergrowth than that of the lowlands. Shrubby species of the region belong to the genera *Miconia*, *Clidemia*, *Psychotria*, and *Piper*. On the fairly open granite summits of the Kanuku Mountains, the moss *Campylopus savannarum* and the fern *Pteridium arachnoideum* are ground covers, while other common species are *Epidendrum decipiens*, *Pitcairnia nuda*, *Chelonanthus uliginosus*, *Myrcia sylvatica*, and *Clidemia dependens*.

(3) *The savannas* of the Guianas are of two types, the true upland savannas and the water-savannas of the coastal belt, the latter not being true climatic savannas.

(a) The upland savannas occupy an extensive area in southwestern British Guiana and are doubtless continued to the east in a more broken form in southern Surinam and French Guiana; they are an eastward extension of the vast savannas of Venezuela and the Rio Branco region of Brazil. With an elevation of 100-150 m., these upland savannas often have an undulating surface, here and there broken with granitic masses which are sometimes, like the Kanuku Mountains, extensive and heavily forested. Rainfall probably does not much exceed 1500 mm. annually, occurring essentially all within four months; therefore these appear to be true climatic savannas. They are, for the most part, bunch-grass savannas, the principal grasses being species of *Andropogon*, *Cymbopogon*, *Trachypogon*, *Elyonurus*, *Paspalum*, *Arundinella*, and *Heteropogon*. Among sedges, which in places are more dominant than grasses, are species of *Cyperus*, *Carex*, *Hemicarpha*, *Dichromena*, *Scleria*, and *Mariscus*. Toward the beginning of the wet season numerous subprostrate legumes, such as *Grimaldia hispidula*, *Chamaecrista flexuosa*, *Indigofera pascuorum*, *Eriosema lanceolatum*, and *Tephrosia cinerea*, are noteworthy, while more showy

plants are *Cyrtopodium cristatum, Hippeastrum solandriflorum* and *Curculigo scorzoneraefolia.* The predominant woody plant of the savannas is *Curatella americana,* while other species occurring in some abundance in open places are *Bowdichia virgilioides, Byrsonima verbascifolia, Sauvagesia Sprengelii,* and *Xyris* spp., and in "bush islands" *Byrsonima crassifolia, Hirtella* spp., *Pagamea capitata,* and *Clusia* spp. Oases of *Mauritia flexuosa* are abundant, and watercourses, like the Rupununi and Takutu Rivers, are lined with low forest in which the families *Flacourtiaceae* and *Leguminosae* predominate.

The transition from savanna to rain-forest (at least in the Kanuku region) is abrupt, the junction being characterized by such species as *Cochlospermum vitifolium, Vitex Schomburgkiana, Allophylus occidentalis,* and *Vochysia* spp. Throughout the savannas are to be found small shallow ponds with an interesting zonal vegetation, the borders being occupied with such species as *Mayaca Aubleti, Cipura paludosa, Herpestis* spp., *Drosera sessilifolia,* and members of the *Eriocaulaceae, Butomaceae,* and *Cyperaceae.* Water plants are *Eichhornia diversifolia, Jussieua sedoides,* and *Utricularia mixta.*

(b) The wet savannas near the coast are comparatively small, forming sharply limited areas in swampy forest and sometimes being below sea-level. The bulk of the vegetation in this region is made up of *Rhynchospora* sp., while other common species are *Sacciolepis striata, Eleocharis geniculata, Hymenachne auriculata, Panicum elephantipes,* and sometimes *Typha angustifolia.* These savannas appear to be of topographic or edaphic origin. In the near interior, savannas somewhat intermediate in type between these swamp savannas and the true upland savannas are met with, but none of them appears very extensive.

(4) *A highland area* in western British Guiana culminates in Mount Roraima, an eastern peak of the little-known Pacaraima Range which divides Venezuela from Brazil. This range without doubt has a higher percentage of floristic endemism than any other part of tropical America, if not of the entire world. The portion of the area lying in Guiana is comparatively small but is perhaps better known than the Venezuelan portion. The country rock in the vicinity of Mount Roraima is chiefly iron laterites, the slopes are diabase, and the plateau is sandstone. Other sandstone areas occur as far east as the Kaieteur region and probably also in southern Surinam. Both savannas and rich forest, forming a broken pattern, are found between Mount Roraima and Kaieteur.

Around the base of the cliffs of Mount Roraima is a cloud zone, characterized by low gnarled forests of species of *Lauraceae, Guttiferae, Melastomataceae, Compositae,* and *Palmae;* the trees are coated with orchids, bromeliads, and masses of soaking bryophytes. The summit is bare rock except where soil has collected in rifts of the stone. In these rifts grow wiry shrubs of such genera as *Ilex, Myrcia, Befaria,* and *Phoradendron,* a few small trees (*e.g. Didymopanax, Stifftia,* etc.), and many herbaceous plants (orchids, ferns such as *Pterozonium* spp. and *Syngramma* spp., *Mikania, Heliamphora,* etc.).

*Chief plant groups:* Considering the Guianas as a whole, there seems no doubt that the *Leguminosae* is represented by the most species. Other important groups, from a numerical point of view, and in approximate order, are: *Pteridophyta, Orchidaceae, Gramineae, Cyperaceae, Melastomataceae, Rubiaceae, Piperaceae, Euphorbiaceae, Palmae, Compositae,* and *Apocynaceae.* The relationships of the flora are predominantly Amazonian, although a great many species and some genera are endemic, this being especially true of the Mount Roraima region. Estimates of the total number of flowering plants and ferns of the Guianas range from 7000 to 10,000.

*Collectors:* Our knowledge of the flora of the Guianas is derived from work done by innumerable collectors, of whom the following immediately come to mind: the SCHOMBURGK brothers and JENMAN (in British Guiana), HOSTMANN and KAPPLER (in Surinam), and AUBLET, SAGOT, and MÉLINON (in French Guiana). Following these come a host of other field workers, including professional taxonomists, foresters, native collectors, and casual travelers, each of whom has contributed items of value.

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LYMAN B. SMITH: **The Vegetation of Brazil**:- Brazil's three and a quarter million square miles fall into two major phytogeographic areas, the Amazon Basin or Hylaea and the extra-Amazonian or "generalized" area.

The Amazon Basin comprises roughly forty per cent of Brazil's total area. From the narrow end, where the Amazon meets the sea, the Basin rises inland very slowly and evenly, having been submerged in comparatively recent geologic times. Its flora is remarkably uniform in sharp contrast to the diversity of the "flora geral" of the plateau area of Brazil. The dominant species change from one part of the Amazon Basin to another, but they have much the same environment, follow the same pattern of succession and give the same total picture. The governing factors are the even high temperature, the heavy rainfall and the alluvial soil.

Thus the jungle, which is the dominant Amazonian cover, is divisible into three general ecological types according to the water available. The bench or upland jungle (mattas de terra firme) occurs on land a few meters or more above flood-level and is characterized by the castanheira do Pará (*Bertholletia excelsa*). The varzea or flood-plain jungle is inundated each year and, south of the river, its wetter soil is typified by seringueiras or rubber-trees (*Hevea brasiliensis*). The igapó or continuously inundated jungle occurs along river margins or mixed with the flood-plain or even isolated in the upland jungle as opportunity offers. It normally contains such plants as the arapary (*Macrolobium acaciaefolium*), the tachy (*Triplaris surinamensis*) and the mamorana (*Bombax aquaticum*).

Geographically the Amazon Basin is divisible into two zones, the upper extending from the Andes to the mouth of the Rio Negro, and the lower from there to the sea. The vegetation of the upper zone is somewhat more luxuriant due to the heavier rainfall, but the contrast is faint compared to those between the zones of the flora geral, and near the sea there is a recurrence of heavy rainfall and thicker vegetation reminiscent of the upper Amazon. Both zones are divided into northern and southern subzones by the Amazon itself, or this may be considered the primary division with almost equal justice. At least many species, including *Hevea brasiliensis*, are almost wholly restricted to the relatively richer southern drainage of the basin.

Although the Amazonian vegetation is much more continuous than that of the plateau area, it does contain isolated outposts from other zones, especially from the campo or prairie. The outposts of campo are much more frequent in the lower Amazon Basin and at times are very extensive as along the Rio Branco and on the Island of Marajo where they furnish important pasturage. Most of their species are either those of the main campo zone or else of general tropical distribution.

Along the boundary with the Guianas and Venezuela, Brazil includes a very narrow strip of mountainous territory. From Mount Roraima westward the range is of great geologic age and its flora is characterized by a high degree of endemism and affinities with the Andean flora. So little is known about the region and so large a proportion of it lies in Guiana and Venezuela that it has received scant attention in classifying the vegetation of Brazil, but ultimately it may well be considered a separate zone.

The remaining sixty per cent of Brazil's area is concentrated in the central plateau southeast of the Amazon Basin. The flora of the plateau or flora geral is an exceedingly diverse one, contrasting sharply within itself as well as with the Amazonian flora and capable of almost endless subdivision. The predominant type of the flora geral is the subarid plain or campo, yet this is an average which includes as well the near desert of the northeast and the rainforest of the southern coast ranges.

The flora geral falls into six zones. The first zone occupies the north central part of the plateau, chiefly in the states of Maranhão and Piauhy and is the zone of cocaes or what we might call palm-forests since the large and nearly pure stands of the babassú (*Orbignya Martiana*) are the dominant feature. It is also a dominant economic feature in the life of that region, yielding important oils and cattle-food.

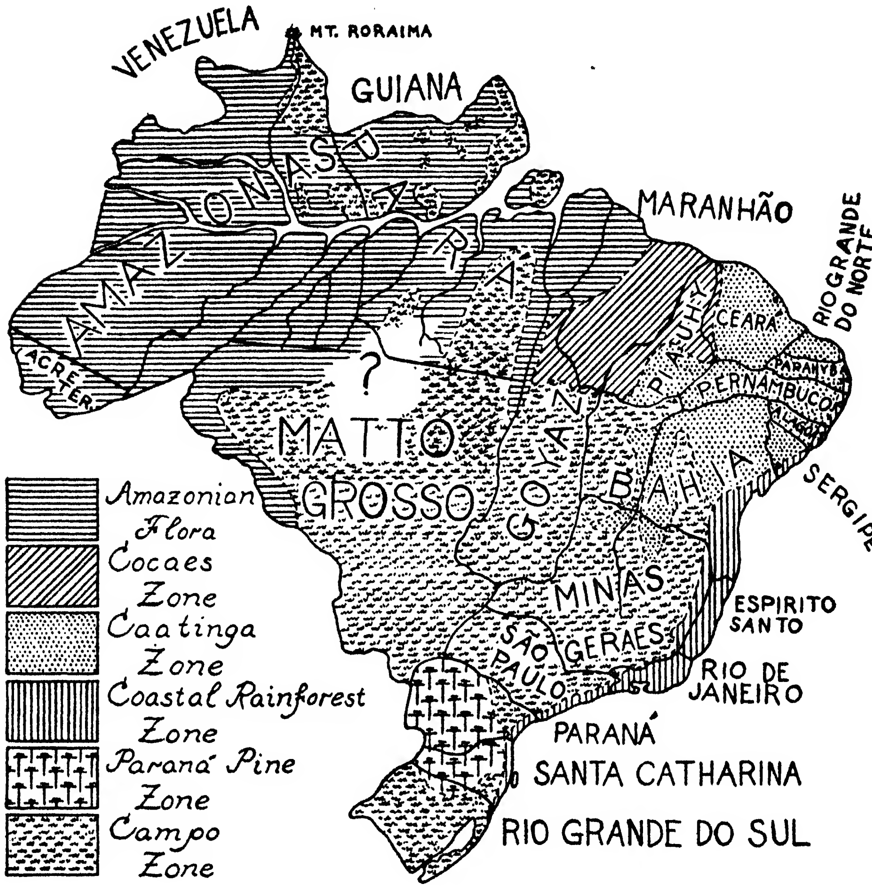
To digress a little, the term, cocaes, is an illustration of the Brazilian's innate talent for ecology. The Brazilian farmer never heard of ecology and its system of designating a type of vegetation by tacking an "etum" after the scientific name of the dominant species, yet he does exactly the same thing with the common name and the termination "aes" and could doubtless claim "priority" for his method. Furthermore he recognizes such endless fine shadings of vegetative pattern that the foreign botanist is hard put to follow him.

The soil of the cocaes zone is porous so that the six months of rain support perennial streams, in sharp contrast to the northeastern zone in which the cocaes was included in earlier ecological systems. Actually the cocaes zone is more nearly related to Goyaz and Matto Grosso than to the Northeast.

Within the cocaes zone are numerous isolated sections of other floras. There are the campos cerrados or high plains, the caatingas or arid forests, the carnaubaes or forests of wax palm (*Copernicia cerifera*) and the forests of burity (*Mauritia flexuosa*) or assahy palm (*Euterpe oleracea*), the tombadores or semideserts, the hydrophytic lake and river margins and the river forests all scattered through the cocaes zone and on the west a border of carrascos or grassy and brushy lowlands forming a transition into the Hylaea.

The caatinga zone in the northeast is the most arid of all Brazil, taking its name from the characteristic scrub forest formation. The aridity is due principally to the impervious nature of the soil, which sheds water with such rapidity as to cause floods in periods of heavy rainfall and retains no moisture for periods of drought. The recurrent droughts have caused much suffering while man has aggravated the trouble by denuding the country of much of its forest cover. Now the government is taking a hand with reservoir construction and reforestation and the situation is on the mend. The soil is fertile and does well under irrigation.

Caatinga is a very broad term embracing many different associations but basically it is an open scrub forest composed almost wholly of deciduous trees, only the palms, the joazeiro (*Zizyphus joazeiro*) and the oiticica (*Licania rigida*) retaining their leaves in the dry season. The inhabitants distinguish four types of caatinga largely on size and density of growth, while LUETZELBURG in his detailed studies of the




THE PRINCIPAL VEGETATION TYPES OF BRAZIL (*Original*).

region makes many more according to the dominant species.

The campos and forests are the principal variations from the caatinga in the Northeast. The true forest growth was much more prevalent here before the advent of the white man, but the specialized nature of the caatinga species argues that they must have been well developed before man's devastation aided their increase.

As if in compensation for the climate, the Northeast is blessed with a number of important economic plants growing with little or no cultivation. Foremost of these is the carnauba or wax palm (*Copernicia cerifera*), a plant of river margins but also able to thrive in dry areas. Its most important commercial product is wax, but the natives use it for heavy construction, thatch, furniture, cordage, paper, and food for man and beast. Various species of mandioca (*Manihot*) grow with a minimum of cultivation and their roots dried and ground provide the staple flour of the region. The joazeiro (*Zizyphus joazeiro*) is an important forage plant because it stays green in periods of drought. In addition it furnishes timber and edible fruit. The jurema (*Acacia jurema*) is another tree of sufficient size for timber. On account of the war, the oiticica (*Licania rigida*) has sprung into prominence as the principal substitute for tung oil in the manufacture of paint. The mangaba (*Hancornia speciosa*) gives rubber and edible fruit. The caruá (*Neoglaziovia variegata*) grows wholly without cultivation and is the main source of cordage in the region.

The third zone of the flora geral is that of the coastal rainforest, a narrow strip running from the latitude of Rio Grande do Norte to the Herval and Tapes Ranges in Rio Grande do Sul. This was the "Dryades" of MARTIUS. Lying directly in the path of the strongest wave of Brazilian colonization, it has suffered heavily and is now far from continuous. Originally it was a close second to the Amazonian forest for its height and luxuriance.

The trees composing the coastal rainforest show a great diversity of species just as in the Amazonian flora, and we miss the pure stands of palms characteristic of the cocaes and parts of the caatinga

zone. Also like the Amazon is the mass of liana and epiphytic vegetation covering the trees. This similarity of character is explained by the rich soil and abundant moisture of both habitats. The coastal rainforest lacks the standing water of the Amazon because it is on strongly sloping terrain, but at some points it exceeds the Amazon in rainfall.

Among the woody types there is a great development of *Leguminosae, Rubiaceae* and *Melastomaceae*. Of the epiphytes the *Bromeliaceae* provide by far the greatest bulk of vegetation and the *Orchidaceae* the greatest number of species while the *Polypodiaceae* are the third important family. *Araceae* are rather prominent and there are a scattering of other families in the epiphytes like *Begoniaceae, Gesneriaceae, Piperaceae* and *Lentibulariaceae*.

On account of its rich well drained soil the coastal rainforest is the preferred zone of Brazilian agriculture as evidenced by the leading crops of coffee, cocoa, sugar and cotton. Unfortunately methods of farming have been improvident, because based on burning off the forest and then abandoning the clearing after only a few years' use. This system has caused great inroads on the forest and although attempts are being made at preservation or reforestation at scattered points, the trend is still adverse.

The fourth zone is that of the Paraná pine (*Araucaria angustifolia*) which derives its name from the state where it is most plentiful. This is another zone characterized by large stands of dominant species, like the cocaes zone of the North. In its optimum condition it occupies the southeastern states of Paraná and Santa Catharina. To the northeast it merges with the coastal rainforest and to the south, west and northwest with the campo zone. The typical stands of Paraná pine also contain large amounts of imbuia (*Phoebe porosa*) and herva mate (*Ilex paraguariensis*). In general the forest is very dense and supports numerous epiphytes but occasionally it is open and park-like.

As both the Paraná pine and the imbuia are valuable for their timber, large inroads have been made on the forests and reforestation becomes increasingly important. The herva mate whose leaves are used as a tea over large parts of South America, has fared better and is the best preserved of the three dominant species.

The climate and soil of the Paraná pine zone are favorable for wheat-growing which is increasing steadily in open or cleared areas.

The fifth and most extensive zone of the flora geral is the zone of prairies or campos and occupies the interior of the Brazilian plateau with important outposts in all the other zones including even the Amazonian. It comprises two general types of vegetation, the savannas or partially wooded prairie known in Brazil as campos cerrados, cerrados or campos cobertos, and the campinas known as campos limpos or literally "clean prairie" from its lack of trees. From Paraná and especially from Minas Geraes northward the savanna type is predominant.

The sparse tree growth which distinguishes the savanna from the campina is dependent upon the rainfall and water table and fluctuates with them. Heavier rainfall causes more tree growth and consequent extension of the savanna, while drought and fires kill off the young trees and enlarge the campina area. The two types form an intricate and constantly changing pattern. As the terrain is rolling and without sharp contours there is rarely a sharp division between savanna and campina but rather a gradual blending.

The bulk of the herbaceous vegetation is gramineous but many other families are represented. The grasses may be either a hard perennial or a soft short-lived type.

The majority of the arboreal species of the savanna are legumes like *Plathymenia reticulata* or *Bowdichia virgilioides*, but other families are represented by a few very common and widespread species as *Curatella americana* of the *Dilleniaceae, Tecoma caraiba* of the *Bignoniaceae, Qualea grandiflora* and *Salvertia convallariodora* of the *Vochysiaceae* and *Byrsonima* ssp. of the *Malpighiaceae*.

The savanna vegetation is in the lower and moister parts of the campo, while the upper slopes support only grass and some of the hills are practically bare and are called morros pelados, literally "bald hills" or "balds". The trees may occur in pure stands or as mixtures of several species. The palms are frequent in pure stands, especially along river-margins.

The campo zone as a whole owes its character to the relatively low rainfall which is insufficient to support continuous forest. Conversely the lack of forest makes for lower humidity, less resistance to drying winds and consequently less favorable conditions for rainfall.

In the southern extremity of the campo zone in Rio Grande do Sul the terrain is very flat and mostly grass-covered, making excellent pasturage. The majority of the species indicate derivation from the planalto although there are some Argentinian and even Andean elements.

The savannas of the central part of the campo zone in Matto Grosso are characterized by widespread species such as the pau terra (*Qualea grandiflora*) and the mangaba (*Hancornia speciosa*). Although the region is very ancient geologically the vegetation upon it appears to be comparatively recent because so few endemics have developed. The savanna of eastern Matto Grosso is the highland or planalto type and is nearly average for the campo zone. In the western part along the Rio Paraguay there is a more specialized savanna of the pantanal or swamplands, where plants are subjected to alternate drought and great humidity or even inundation. Many of the species have heavy tap roots enabling them to withstand the dry season. The carandá palm (*Copernicia australis*) is the most characteristic plant here, growing along the Rio Paraguay in dense

stands. It does not produce wax like the northern *C. cerifera,* but has a variety of other uses.

The vegetation of the valley of the Rio São Francisco is technically savanna since it is grass with scattered trees, although its appearance is scarcely what one would expect from the term. Since the valley is largely isolated from the main campo zone, its flora is rather distinctive. Here the commoner plants are *Kielmeyera coriacea, Stryphnodendron barbatimao, Terminalia argentea, Magonia glabrata, Anona crassiflora, Byrsonima* ssp., *Caryocar brasiliensis, Qualea* sp. and *Plenckia populnea.*

Two palms, *Syagrus flexuosa* and *Acrocomia sclerocarpa* are typical of the valley and the wax palm also occurs. There are such hard grasses as *Trachypogon polymorphus, Aristida longifolia* and *gibbosa* and *Andropogon Riedelii,* and such soft types as *Heteropogon villosus, Tristachya chrysothrix, Echinolaena inflexa, Gymnopogon spicatus* and *Axonopus barbigerus.*

Completely isolated outposts of the campo zone are the alpine campos on the summits of the higher ranges from one thousand to well over two thousand meters. These occur along the coast range on Itatiaya, Caparao and parts of the Serra dos Orgãos, and also in the interior in Goyaz and in Minas Geraes where candelabra-like *Vellozia* give a distinctive appearance. Endemics are particularly notable, species and even one genus being limited to the few square miles of campo on the summit of Itatiaya.

The sixth zone is the maritime zone comprising the entire coastline of Brazil yet rarely having any appreciable width on any but the largest scale map. Actually it is no more a part of the flora geral than it is of the Amazonian flora, but is classified here for convenience. The strictly marine flora consists almost entirely of algae and phytoplankton with very few vascular plants such as *Ruppia* and *Najas.*

The most notable part of the maritime zone is the mangroves, *Rhizophora Mangle, Laguncularia racemosa* and *Avicennia* ssp. in soft muddy saline habitats. On the open beaches *Ipomoea pes-caprae, Remirea maritima* and *Sporobolus virginicus* are common and grow almost to the water. Farther up are *Ipomoea stolonifera, Stenotaphrum, Cenchrus* and *Chenopodium.*

On the firmer ground inland there is a shrubby growth or even a low forest called restinga and containing such woody plants as *Byrsonima sericea, Protium brasiliense* and *icicariba, Coccoloba* ssp. and *Psidium* ssp. *Cactaceae* and *Bromeliaceae* are frequent.

In the low areas not actually reached by the sea is still another group consisting of *Myrsine, Ocotea pulchella, Alchornea triplinervia* and *Ilex amara.* Elsewhere *Hibiscus tiliaceus* forms great thickets. A number of introduced species like the coconut are found chiefly along the coast. In the interior there are outposts of the maritime zone in saline areas that apparently are the remnants of epicontinental seas.

The present paper is frankly a compilation and is drawn chiefly from the excellent "Phytogeographia do Brasil" of A. J. DE SAMPAIO. For those who wish to study the subject in detail the following abbreviated list may serve as a beginning:

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**The year 1940 marked the hundredth anniversary of VON MARTIUS' "Flora Brasiliensis", for in 1840 the appearance of HORNSCHUCH's treatment of the *Musci* established the format of the series which was to become the greatest of all floristic works. Treating as it did the largest national flora in the world it was only natural that the "Flora Brasiliensis" should exceed all others in sheer size, but beyond that it stands in the top rank for wealth of information and clarity of presentation.**

**It is easier to understand this preëminence of the "Flora Brasiliensis", if we remember that 1840**

marked the reward of over twenty years of preparation first in the field and then in the herbarium. From 1817 to 1820 MARTIUS traveled in Brazil from São Paulo to Pará and thence up the Amazon Basin clear to Peru and Colombia, making copious collections with careful supplementary notes. At the same time he prepared a number of landscapes which illustrated the characteristics of regions traversed and which appeared long after his death as one of the important features of the introductory volume.

After his return to Europe, MARTIUS continued to enjoy the royal patronage which had supported his explorations and was thus enabled to devote himself to the study of the flora of Brazil. From the first, the high quality of his work gained the respect of his colleagues and paved the way for enlisting their interest and coöperation later.

How well he succeeded is attested by the 65 botanists of 9 different nationalities who contributed to the "Flora Brasiliensis" during its 66 years of construction. His successors, EICHLER and URBAN, kept up his high standards, but found the "Flora" with its reputation solidly established and their tasks thereby simplified.

In 1906 the "Flora Brasiliensis" reached its completion with COGNIAUX's work on the *Orchidaceae*. The whole covered 22,767 species, 6,246 of which were illustrated.

Many tributes have been paid MARTIUS* for his great work, but the sincerest is undoubtedly that of close imitation. A hundred years after MARTIUS commenced the "Flora Brasiliensis", Dr. F. C. HOEHNE published the first part of the "Flora Brasilica", essentially a second edition of MARTIUS' work. Thus MARTIUS' inspiration fittingly finds rebirth in Brazil itself.

GRAY HERBARIUM,
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A. A. BITANCOURT: Plant Pathology in Brazil:- Interest in the diseases of cultivated plants was aroused comparatively early in scientific and technical circles in Brazil. The work of DRAENERT in 1869 on gummosis of sugar cane, incidentally the first recognized bacterial disease of a plant, prior to the researches of BURRILL in the United States, GOELDI's reports as a result of his appointment by the Federal Government in 1886 to investigate the root disease of the coffee tree in the State of Rio de Janeiro and later (1888) to report on the grape diseases in the State of São Paulo, attracted the interest of both the Federal and State Governments, which subsequently created permanent research agencies. In the Institute of Agronomy (Instituto Agronómico) maintained at Campinas by the government of the State of São Paulo, the first plant pathologist was appointed in 1888, and in 1896 the German phytopathologist FRITZ NOACK accepted this post. For three years, he investigated the diseases of the principal crops of the State and published several papers, especially on the diseases of coffee, citrus and grapes.

The Federal Government created in 1910 a Laboratory of Plant Pathology at the Museu Nacional in Rio de Janeiro and appointed A. PUTTEMANS (CHRON. 6:235) as its chief. In 1920, the Instituto Biológico de Defesa Agrícola was created within the Ministry of Agriculture in Rio de Janeiro, with, among other divisions, those of plant pathology and plant quarantine. In São Paulo, the Instituto Biológico de São Paulo (CHRON. 1:95, etc.) was established in 1928.

Instruction in plant pathology was at first part of the teaching of Botany or Agriculture and commenced in 1893 in the Polytechnical College of the State of São Paulo (Escola Politécnica de São Paulo). More recently separate chairs of plant pathology were created in the Escola Nacional de Agronomia in Rio de Janeiro, the College of Agriculture at the University of São Paulo (Escola Superior de Agricultura da Universidade de São Paulo) and the College of Agriculture and Veterinary Science of the State of Minas Gerais (Escola Superior de Agricultura e Veterinaria do Estado de Minas Gerais).[1]

*Plant pathological research centers in Brazil today*:- In the last ten years plant pathology has developed rapidly in Brazil. The chief centers (*cf.* CHRON. 7,2:52 *seq.*), where plant pathology is studied at the present time are the Division of Plant Quarantine of the Federal Ministry of Agriculture at Rio de Janeiro (Divisão de Defesa Sanitaria Vegetal) with a laboratory of plant pathology and a field station for research in plant protection at São Bento, near Rio de Janeiro, and the Instituto de Experimentação Agrícola, with a division of plant pathology, near Rio de Janeiro.

In São Paulo, the Biological Institute in the city of São Paulo has a section of Plant Pathology (fungous and bacterial diseases) and a section of Plant Physiology (virus and physiological plant diseases) with the largest staff of plant pathologists in the country. The State's Institute of Agronomy at Campinas maintains a section of Applied Botany, chiefly devoted to plant pathological research and also a laboratory of plant pathology in the department of genetics. In Pernambuco, the Institute for Research in Agronomy (Instituto de Pesquizas Agronómicas), the State Departments of Agriculture in Rio Grande do Sul and Minas Gerais, have laboratories or divisions of plant pathology.

Plant pathological research is also carried out in the departments of Botany or Plant Pathology of the Colleges of Agriculture: Escola Nacional de Agronomia (federal) at Rio de Janeiro, Escola Superior de Agricultura da Universidade de São Paulo at Piracicaba, Escola Superior de Agricultura e Medecina Veterinaria of the State of Minas Gerais and other agricultural educational institutions in the country.

*Plant diseases and agriculture in Brazil*:-

*This volume on "Plants and Plant Science in Latin America" has also been fittingly dedicated to him (*cf.* p. IX, and portrait). A number of the classic vegetation illustrations from vol. 1 of the *Flora Brasiliensis* have been reproduced on plates 5, 8, 10, 13, 15 and 33.

[1]A more detailed account of the history of plant pathology in Brazil may be found in:- PUTTEMANS, ARSÈNE: Some data concerning the history of Phytopathology in Brazil and the first notices of Diseases of Plants in the country. Translated by ANNA E. JENKINS and ANNIE D'ARMOND MARCHANT (Journ. Agric., Univ. Puerto Rico 24, 3:77-107, 1940), *cf.* also CHRON. 6:224.

Contrary to the common belief, a great many crops of the temperate zones are cultivated in Brazil, but most of the chief crops are tropical or subtropical.

Brazil extends from the equatorial regions to the Northern limits of the Southern temperate zone, which, together with the fact that more than half of the most densely cultivated part of the country is at an altitude of from 1500 to 4000 feet, accounts for the very varied character of agriculture.

Rubber and cacao are found in wild or cultivated condition in the equatorial and tropical regions. Cotton, coffee, sugar cane and tobacco have a wide range extending from the purely tropical regions of the North East to the milder climate of the highlands in the southern part of the country. Wheat and other cereals, grapes, European fruit trees, and truck crops, are typical of the southernmost part of Brazil, while corn, beans, rice and other staples are cultivated practically everywhere, but more especially in the densely populated districts of the highlands in the central and southern parts of the country.

In order of importance, however, coffee, cotton, cacao, corn, cassava (*Manihot utilissima*), sugar cane, castor beans, citrus fruits, banana, tobacco and rice are the chief crops of the country.

Although, as already pointed out, the interest in plant pathology was noticeable in agricultural research centers by the end of last century, until recently, for several reasons, plant diseases attracted comparatively little attention outside scientific and governmental circles. An exception should be made, however, of the cultivation of grapes in Southern Brazil. This was chiefly in the hands of Italian and Portuguese growers who brought from Europe the practice of spraying for the control of diseases of the grape and who were spraying their vineyards as early as the close of the last century.

In the more progressive Southern regions until recently coffee was practically the only extensive crop of the country in the hands of more educated and progressive farmers. This has probably been the main factor in delaying for a number of years the introduction of modern methods of disease control. Unlike the plantations of other coffee regions of the world, coffee in Brazil is practically free from any serious diseases such as phloem-necrosis in Dutch Guiana, Colombia and Central America, wilt, die-back, and especially the destructive rust of the plantations of Africa and Asia. Undoubtedly the occurrence of any serious diseases in the coffee plantations of the State of São Paulo would have aroused a keen interest on behalf of the government and progressive planters, as was shown in 1924 when the introduction in the country of the dangerous coffee borer (*Hypothenemus hampei*) finally led to the creation of the Biological Institute in São Paulo (with a staff now exceeding 600), for the sole purpose of doing research and extension work in the field of diseases and pests of cultivated plants and domestic animals.

Brazil's second crop, cotton, is also comparatively free from serious diseases and the extensive adoption of control methods especially in the plantations of the Southern States, is due to the occurrence of several important pests.

To the rapid development of citriculture, around 1930, and the increasing exports of crops to the European market, is due the introduction of modern methods for the control of diseases in orange groves. The necessity of exporting oranges free from blemishes, from orchards where climatic conditions are unfortunately extremely favorable for the development of a variety of fruit blemishes, due to fungi and other microorganisms, impelled the growers, at the advice of official research and extension institutions, to adopt methods of control already successful in other lands, duly adapted of course to the special conditions of the country.

*The problem of plant quarantine*:- With the creation of the Instituto Biológico de Defesa Agrícola in the Ministry of Agriculture, in 1920, with a section of Plant Quarantine (Secção de Vigilancia Sanitaria Vegetal), the Federal Government made the first earnest attempt to bring the introduction of foreign diseases and pests under control. The section was later made an independent division of the Ministry and has developed into an extensive and efficient body with inspectors in the chief cities and ports of the country.

In a country where most of the initiative in the introduction and multiplication of foreign plants of economical value belongs to Government offices, it is not to be wondered that the introduction of pests and diseases from foreign countries is traceable in many cases to experiment stations and agricultural colleges. It is quite probable that such serious diseases and pests as citrus scab and the coffee borer have been introduced from imports made by official institutions rather than by farmers or nurserymen.

The creation of the federal division of plant quarantine and the prohibition of the importation of the most important agricultural plants, except by government offices under controlled conditions, has changed the situation to a great extent. Serious diseases such as citrus canker have already been intercepted and their spread prevented.

It is recognized, however, that in spite of all the care taken in the introduction of new varieties of agricultural plants, there is still a great danger of introducing destructive plant pathogens. This is especially true in the light of the more or less recent discovery of strains of fungi and other disease agents with widely different aggressivity. To be taken into account also is the ever increasing number of virus diseases, extremely difficult to detect, even with the best methods of plant quarantine. Regardless of the value of some of the new varieties, it is believed that (as has already

been done in the past years), the possibility of introducing such diseases makes it necessary to prohibit the introduction of the more important crops, except in very special cases.

INSTITUTO BIOLÓGICO,
São PAULO.

H. K. SVENSON: **The Vegetation of Ecuador, a Brief Review**:- Due to its rugged topography and limited transportation facilities Ecuador is botanically one of the least known, though one of the richest, countries of S. America. Within 100 mi. the land rises from sea level to over 20,000 feet, as represented in a straight line from the seaport of Guayaquil to the top of Mt. Chimborazo. It is in the cool central valleys of the Andes, along the chain of cities extending southward from Quito to Loja that most botanical collecting has been done. The wintry slopes of Cotopaxi, Antisana, Corozon, Chimborazo, and other snow-capped volcanoes which rim this central valley are accessible by pack-mule; the hot climate and thick jungle of the lowlands have been much less tempting to the botanist.

In addition to my own observations I have relied on the accounts of CHAPMAN, "The Distribution of Bird-Life in Ecuador" (Bull. Amer. Mus. Nat. Hist. 55, 1926), and the second volume of "Notes of a Botanist on the Amazon and Andes," by RICHARD SPRUCE. The geographical subdivisions are those employed by DIELS in his "Beiträge zur Kenntnis der Vegetation und Flora von Ecuador" (Bibliotheca Bot. 116:1/190, 1937):

- I. West Ecuador, which is synonymous with the western coastland.
  - 1. Northern coastland.
  - 2. Southern coastland.
- II. Middle Ecuador, the Sierran-Andean highlands.
  - 3. Forest slopes of the West Cordillera.
  - 4. Valley of the West Cordillera.
  - 5. Forest slopes of the East Cordillera.
  - 6. The Andean Ceja.
  - 7. The inter-Andean cultivated land.
  - 8. The Paramos.
  - 9. The high-Andean slopes.
- III. East Ecuador.

1. *The northern coastland* is a continuation of the wet tropical forest of Colombia, and it extends along the coast as far south as Cape Pasado (just below the equator), joining inland in the upper reaches of the Esmeraldas River with the dense forest of the lower Andean slopes. It is almost unknown botanically.

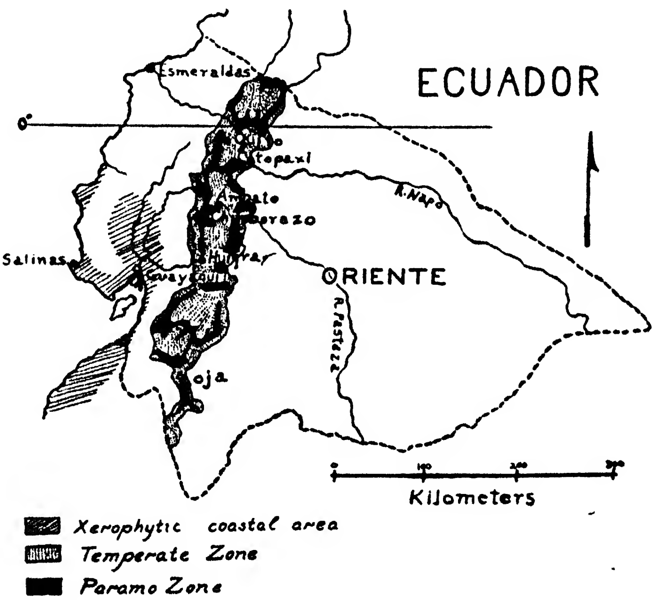
2. *The southern coast* is an arid zone extending inland from the Pacific sometimes as much as 25 miles. The coast itself is a continuation of the western Peruvian desert, with a normal rainfall of only 4-6 inches, which falls from February to April. This dry area — due to the cold waters of the Humboldt Current — extends northeastward, though with increasing precipitation, to Guayaquil itself, lying 70 miles away at the head of the Gulf of Guayaquil. In occasional years the rainfall along the coast may reach 30 or even 50 inches. At such times the gray and lifeless landscape becomes transformed into a carpet of green. Western Ecuador is a broken, hilly country — sometimes erroneously called a coastal plain — with low mountains frequently rising to 2500 feet. Some of these, such as the Colonche Hills, support a permanent dense jungle vegetation on the western side, a condition which allows the growth of tropical fruits even at sea level, as at Manglaralto and several other places. In rainy periods the sandy desert region of southwestern Ecuador is covered with low grasses (*Anthephora, Chloris, Cenchrus*), giving way a short distance inland to a deep black loam which at the beginning of the rains is carpeted with white *Hymenocallis* (*Amaryllidaceae*) and is later covered with savannas of *Pennisetum* often four or five feet tall. In this grassland are isolated leguminous trees (*Prosopis, Acacia, Pithecolobium, Tamarindus*), the evergreen barbasco (*Jacquinia macrocarpa*) with orange fruits used as a fish-poison, several species of *Capparis*, and occasionally the pink-flowered *Carica paniculata*. Along the sandy margin of the sea are *Ipomoea Pes-Caprae* and *I. Kinbergi*, species of *Pectis* (*Compositae*) and *Coldenia* and isolated stunted shrubs of *Maytenus* (*Rhamnaceae*), *Acacia macrostachya*, and the spinescent *Scutia maritima* (*Rhamnaceae*). Sparse groves of *Loxopteryguim Huasango* (*Anacardiaceae*), a tree with blistering juice, occupy the low ridges near the coast, together with *Vallesia*, tall cactus trees (*Cereus*), *Croton* bushes, and many spinescent *Leguminosae*. Toward the end of the rains these thickets become entangled with cucurbits and *Convolvulaceae*, making passage very difficult. Further inland *Cochleospermum* becomes a dominant tree, extending to the jungle-covered hills which lie midway between the coast and Guayaquil. Along both sides of the Gulf extend vast mangrove swamps. Between the coastal mountains and the Andes lies an extensive valley occupied by the Daule and Yaguachi Rivers, which converge on Guayaquil. During the rainy season the land is flooded and there are vast savannas with isolated leguminous trees, the wettest places being covered by *Hibiscus, Canna, Mimosa, Sagittaria*, and sedges of various sorts. These savannas extend eastward to the extensive plantations of sugarcane and tropical fruits lying at the base of the Andes.

3. *The vegetation of the forest slopes of the Western Cordillera* is known only in a few places. It is a tropical rainforest similar in appearance to that along the coast at Manglaralto, with *Cecropia, Ochroma* (balsa), large bamboos, *Sapindus, Bixa*, etc., the trees loaded with orchids and bromeliads (which apparently do not bloom during the rainy season), *Araceae, Costus*, the yellow-flowered twining vine *Prestonia glabrata* (*Apocynaceae*), and in wet places *Selaginella, Hymenophyllaceae*, and other ferns. This forest is much more extensive to the northward, and on the foggy slopes west of Quito it reaches upward in places to at least 10,000 feet.

4. *Long valleys of the Western Cordillera.* These valleys can be seen, especially

that of the Chanchan River, along the railroad from Guayaquil to Quito. From Naranjapata (1500 ft.), which still lies in the rainforest, to Huigra (3700 ft.) the vegetation changes with remarkable quickness, due to the fact that rainfall is to a large extent cut off by the western slope of the Cordilleras. The vegetation rapidly becomes dwarfed, and the open summits of the ridges appear unexpectedly. The landscape is dominated by Composite shrubs such as *Piquiera peruviana* and *Helianthus Lehmanni*, and great banks of giant terrestrial bromeliads (*Tillandsia Fraseri*) give way upwards to *Fourcroya cubensis*, *Agave americana* (the flowering stalks rising to 6 or 8 feet), *Cereus*, and tall grasses — a strongly xerophytic assemblage. Further upward at an elevation of 4000 to 6000 feet there are occasional forests of *Cinchona* in *Tradescantia*, and *Begonia* in the openings. Woody lianas are rare, but thorny bamboos are abundant. Tree Composites (such as *Tessaria legitima*) are abundant along the river gravels. Everywhere there are bromeliads and orchids, and SPRUCE has described the region as abounding in mosses.

6. *The Andean ceja.* The upper level of the Andean forest, called "ceja," is more easily reached than the lower slopes. The forest border at about 10,000-11,000 feet consists of trees 30-40 feet high. Leaves are of middle size and hard texture; in the dry season from July until September there is little growth or flowering. There are very few lianas, but the trees are covered by lichens and tank-bromeliads. As trees may be mentioned *Sessea* (*Solanaceae*), *Buddleia*, *Miconia*, *Cyathea* (tree fern); various Composite shrubs, *Solanum*; of




THE VEGETATION OF ECUADOR (*Original*).

the regions of cloud condensation, and trees of *Clusia Pavonii* up to 15 m. high. In general the vegetation is disappointing — an occasional *Begonia* (*B. griseocaulis*), a small *Calceolaria* (*C. gracilis*), *Peperomias*, *Alternantheras*, and an unexpected prevalence of European weeds. This dry inner section of the Cordillera has, according to DIELS, been too little collected for adequate botanical analysis.

5. *Forest slopes of the East Cordillera.* The wall of the East Cordillera is pierced by roads in only three places: at Napo, at Pastaza, and at Paute, leading to the wilderness of the eastern slope. In general the vegetation is like that of the western slopes. Most collecting has been along the Pastaza River. The rainfall is heavy, giving rise to many waterfalls, and the forest abounds in trees of the *Palmaceae*, *Flacourtiaceae*, and *Solanaceae*, with tender-leaved plants such as *Fuchsia*, *Heliconia*, herbaceous plants *Thalictrum*, *Gunnera*, *Ranunculus*, etc. In the transition between the "ceja" and the Paramo are many Erica-like shrubs, such as *Hypericum laricifolium*.

7. *Inter-Andean cultivated land.* In extensive areas under intense cultivation the native flora has practically ceased to exist, as in the district east of Alausi. Here the chief species of interest is a cactus (*Trichocereus Pachanoi*) prominent along the railway.

8. *Andean paramos.* "Paramo" means in general usage the area above the timber line, ordinarily from 9000 to 12,000 feet altitude. The greatest development is of bunch grasses, the spaces between being occupied by a large number of small herbaceous plants and a few dwarf shrubs. The grasses are mostly *Calamagrostis* (*C. Humboldtiana*) and *Festuca*. The herbaceous plants are mostly woolly rosette plants: *Compositae*, such as *Erigeron*, *Wer-*

*neria*, and *Hypochaeris*; or creeping plants such as *Alchemilla*, *Arenaria*, or *Gentiana* species. The dwarf shrubby plants are *Baccharis humifusa*, *Aphanactis Jamesoniana*, etc., or plants with woody bases, such as *Geranium ecuadorense*. Associated with the bunch grasses are cushion plants such as *Plantago rigida* and the peculiar long-stalked *Espeletia* (*Compositae*). The soil is usually a fine-grained gray tuff, but it varies from acid to even saline. *Calceolaria* and *Bomarea* are practically confined to the western cordillera, not a single species of these genera having been found by JAMESON at a corresponding elevation on the eastern chain.

9. *High-Andean slopes*. These slopes, above 4000 feet on the higher volcanic slopes, have much in common with the puna zone of Peru. They have been studied by ESPINOSA (Bot. Jahrb. 65:120/211, 1932). There are rapid changes from a blooming season to arid, almost desert conditions. Such arid hillsides near Quito are characterized by *Cactus*, *Bidens* and similar *Compositae*, prostrate *Alternantheras* and *Euphorbias*, *Agave*, etc., much resembling the flora of the coastal region.

10. *East Ecuador*. This is the least known part of Ecuador, practically the entire province of Oriente, including the vast unexplored rainforest of the Amazon drainage. SPRUCE's voyage on the Maranon-Pastaza Rivers is perhaps the best account of the region.*

BROOKLYN BOTANIC GARDEN,
BROOKLYN, N. Y.

ERNESTO MOLESTINA O.: **Reseña Agrícola del Ecuador**:- La República del Ecuador presenta múltiples aspectos al observador científico que, desde el punto de vista agrícola-botánico, desea inquirir consecuencias de orden económico.

Esa multiplicidad de aspectos se debe a la privilegiada situación geográfica de este país que, situado sobre la línea ecuatorial a orillas del Oceano Pacífico, presenta una topografía variada con diversidad de climas, terrenos cultivables desde el nivel del mar hasta doce mil pies de altura y una flora de gran variación y riqueza.

Económicamente hablando, el Ecuador puede cultivar, casi sin excepción, todos los productos tropicales y subtropicales de las regiones cálidas-húmedas y cálidas-secas, muchísimos de las zonas templadas y los de las regiones frías andinas.

El recuento sería interminable si tan sólo hubiere de enumerar los valiosísimos recursos vegetales de las inmensas selvas vírgenes que, entre 1.500 y 6.500 pies de altura, se extienden a Oriente y Occidente de las dos cordilleras de los Andes que cortan el país de Norte a Sur.

En estos bosques, incompletamente estudiados aún por botánicos y naturalistas, se encuentran riquezas tan notables como el "caucho" (*Castilloa elastica*, *Siphonia elastica*, etc.), la "quina" o "cascarilla" (*Cinchona succirubra* y otras variedades), la "tagua" o "cadi" (*Phytelephas aequatorialis*), el "palo de Balsa" (*Ochroma Lagopus*), la "toquilla" (*Carludovica palmata*), *Carludovica imperialis*, varios "Barbascos" (especialmente *Lonchocarpus nicou*), el "ururi" ("curare") (*Strychnos toxifera?*), la "palma real" (*Cocos butyracea*), la "palma de cera" (*Copernicia cerifera?*) y otras muchas palmeras útiles; fibras de gran valor como la "chambira" (*Astrocaryum vulgare*, *A. tucuma*) y la "pita" (*Bromelia amazoniensis*, o *B. curaua*); centenares de especies de maderas preciosas como la "caoba" (*Swietenia mahagoni*), el "cedro" (*Cedrela* var. sp.), el "ébano" (*Diospyros ebenum*) y por último, una variadísima colección de cyclantáceas, helechos y orquídeas bellísimas (entre éstas la *Vanilla odorata* y otras variedades) y gran número de plantas medicinales y de aplicación económica poco estudiada.

Entre las dos cordilleras de los Andes del Ecuador se extienden las mesetas y valles interandinos de clima templado y algo frío entre 6.800 y 12.000 pies sobre el mar. Esta región habitada por agricultores indígenas abastece a todo el país en cereales, tubérculos, legumbres y hortalizas, forrajes y ganados así como frutas de la zona templada, entre las cuales hay algunas típicamente ecuatorianas de indiscutible valor.[1] La región interandina produce fibras de valor industrial y plantas oleaginosas.[2]

La más importante zona de producción es sin duda hoy, el litoral ecuatoriano, que abarca desde el nivel del mar hasta el pie de la cordillera occidental de los Andes.

En esta extensa región de clima caliente y húmedo (con lluvias entre 40 y 160 pulgadas), (salvo ciertas zonas secas de la costa cerca del mar), el cultivo principal es el *cacao*, que con su variedad típica ofrece al mercado internacional un cacao de calidad superior (Summer ariba) calificado con los mejores de Ceylán y Venezuela. Pero, los ricos suelos de esta región ecuatoriana, producen la gran mayoría de los productos de exportación del Ecuador.

Entre estos últimos, citemos principalmente: el café, el arroz, el caucho, el kapoc y otras lanas vegetales, la toquilla (con la cual se fabrican los famosos sombreros "Jipijapa", "Montecristi" impropriamente llamados "Panamá Hats"), la tagua o marfil vegetal (*Phytelephas aequatorialis*), el Balso (*Ochroma* sp.), la guadua

*For a recent treatment on the Ecuadorean paramos see C. W. T. PENLAND, The alpine vegetation of the southern Rockies and the Ecuadorean Andes. Colorado College Publication, May 1941, General Series No. 230. Studies Series No. 32.

[1]Ver: "Frutas ecuatorianas de valor económico" por WILSON POPENOE. (Economic Fruit-Bearing Plants of Ecuador).

[2]Los principales cultivos de la región interandina son: maíz, trigo, cebada, centeno, avena, lentejas, habas y frejoles, patatas, la quinoa (*Chenopodium quinoa*), el Chocho (*Lupinus humilis*), las Ocas (*Oxalis tuberosa*), los mellocos (*Ullucus tuberosus*), la alfalfa, los tréboles y otras leguminosas y gramíneas forrajeras, la zanahoria y la arracacha (*Arracacia esculenta*), la remolacha etc. Entre las plantas industriales: la cabuya (*Agaves y Fourcroyas*), la higuerilla (*Ricinus communis*), el anís (*Pimpinella anisetum*) y en los valles semi cálidos, el algodón, la caña de azúcar, el tabaco, el café, el ajonjolí (*Sesamum orientale*) etc.

(*Guadua angustifolia* y *G. latifolia*), el mangle (*Rhizophora mangle*), el achiote (*Bixa orellana*), bananos, aguacates, piñas, mangos y frutas cítricas etc. La región del Litoral abastece además todo el consumo del país en azúcar y alcoholes; en féculas como la yuca (*Manihot*) y el Plátano (*Musa paradisiaca*), el camote (*Batatas edulis*) y otras; en aceites, como el coco, la higuerilla, el piñón (*Jatropha curcas*), el maní (*Arachis hypogaea*) etc., en algodón y otras fibras, en tabaco, en frutas y otros muchos productos tropicales, de consumo en el país.

Como se puede ver por lo anteriormente expuesto, el Ecuador ofrece vasto campo de acción y oportunidad para el empleo de capitales que se dedicaren a la explotación de las riquezas de origen vegetal. Creo oportuno estudiar, por grupos, algunos cultivos económicos, que, en las actuales circunstancias por las que atraviesa el mundo, serían interesantes para el mercado norteamericano y, según mi opinión, podrían establecerse en gran escala en el Ecuador.

*FIBRAS Y LANAS VEGETALES:-* El Kapok o Lana de Ceibo (*Ceiba pentandra* y otras variedades, *Eriodendron anfractuosum, Bombax* sp.) es una de las lanas más importantes que exporta el Ecuador y que tiene gran demanda. Grandes extensiones se podrían utilizar en el Litoral, en su zona semi seca, para este cultivo. La Paja Toquilla (*Carludovica palmata*) es una fibra de la cual se podrían hacer cultivos científicos. Igualmente la Paja de Mocora (*Astrocaryum spinosum*) que sirve para la confección de buenas hamacas y esteras. La cabuya blanca (*Fourcroya gigantea*) y la cabuya negra (*Agave americana*) son muy utilizadas en el país y en la época actual se está exportando. La paja de escoba (*Sorghum vulgare*) tiene también importancia. Actualmente se cultivan pero no se exportan: el algodón (*Gossypium* var. sp.) que abastece gran parte del consumo interno; *la pita* (*Bromelia amazoniensis* o *B. curaua*) y la chambira (posiblemente *Astrocaryum vulgare* o *Astrocaryum tucuma*) son fibras excelentes para cordeles. En escala que todavía no es comercial se comienzan a cultivar: el Abaca o fibra de Manila (*Musa textilis*), la Paka (*Urena lobata* y *U. sinuata*), el yute (*Corchorus capsularis*), el Ramie (*Boehmeria nivea*), el lino (*Linum usitatissimum*) y el cáñamo (*Cannabis sativa*). También se podría cultivar el formio (*Phormium tenax*) y otras fibras de esta categoría.

*ACEITES Y GRASAS VEGETALES:-* En el Ecuador se utilizan muchos aceites y grasas vegetales para su consumo interno extraídos de las siguientes oleaginosas: semilla de algodón, coco (*Cocos nucifera*), Higuerilla (*Ricinus communis*), maní o cacahuete (*Arachis hypogaea*), cacao (*Theobroma cacao*), palma real (*Cocos butyracea*), Ajonjolí (*Sesamum orientale*), Piñón (*Jatropha curcas*) y algunas otras semillas de palmas silvestres. También se cultivan el Girasol (*Helianthus annuus*), la Oliva (*Olea europaea*), la nuez (*Juglans regia*) y el Tocte (*Juglans honorei*), la palma africana de aceite (*Elaeis guineensis*), el Tung (*Aleurites fordii*), la soya (*Glycine soja*), etc.

En realidad la industria de aceites es incipiente en el Ecuador, las fábricas usan una gran cantidad de materia prima obtenida de plantas oleaginosas silvestres; pero se trata de establecer grandes cultivos que sirvan para desarrollar en gran escala la industria y proveer la materia prima para exportación.

*PLANTAS MEDICINALES, INSECTICIDAS, etc.:-* Numerosas plantas medicinales se producen espontáneamente en Ecuador, pero son pocas las que se explotan comercialmente en gran escala, no existiendo tampoco, cultivos de estas plantas. Citaremos las principales: La "quina" o "cascarilla" (*Cinchona* sp.), como se sabe es nativa de las cordilleras ecuatorianas en donde abundan las variedades de cinchona, siendo la principal *C. succirubra* (cascarilla roja) que es la que más se exporta. Las variedades nativas son una base excelente para nuevos cultivos de variedades, como la *C. Ledgeriana* de alto porcentaje en quinina. El Gobierno Ecuatoriano presta especial apoyo a los capitales que se inviertan en estos cultivos. El "Barbasco" (nombre genérico para las plantas que producen rotenone) especialmente *Lonchocarpus nicou*, y otras variedades de alto porcentaje de alcaloides es un cultivo que tendría éxito. La "nuez de Kola" (*Kola acuminata*), la "zarzaparrilla" (*Smilax officinalis*), el "curare" (*Strychnos toxifera*), el "Bálsamo de Tolú" (*Myroxylon balsamum*), la "copaiba" (*Copaifera* sp.), la "coca" (*Erythroxylon novogranatense*), la "Ratania" (*Krameria triandra*), el "Guayaco" (*Guaiacum officinale*), el "campeche" o "huarango" (*Caesalpinia horrida*), el "condurango" (*Marsdenia cundurango*), serían plantas de fácil cultivo en Ecuador. Igualmente se podrían citar: el "anís" (*Pimpinella anisetum*), la "ipecacuana" (*Psychotria* sp.), las "manzanillas" (*Anthemis nobilis, Matricaria chamomilla*), varias "mentas", la "citronela" (*Andropogon nardus*), el "pelitre" o "piretrum" (*Chrysanthemum cinerariaefolium*), la "adormidera" (*Papaver somniferum*) y un centenar más de plantas medicinales cuya importancia en medicina es reconocida.

*CAUCHO Y OTRAS GOMAS, CERAS, RESINAS etc.:-* Existen terrenos y zonas climatéricas muy adecuadas para el cultivo del Caucho en gran escala. Las mejores regiones en donde el caucho de la variedad *Castilloa elastica* se produce en forma espontánea y en donde se produciría bien la var. *Hevea brasiliensis*, se extienden en grandes fajas al pie de la cordillera occidental de los Andes, a alturas desde los 700 m. sobre el nivel del mar hacia sitios más bajos cercanos de la Costa. En la cordillera Oriental de los Andes en los grandes bosques del Oriente, existen var. de caucho: *Siphonia elastica* (Pers.) y el *Hevea* cerca del Amazonas. En todos estos bosques

existen plantas productoras de ceras, chicles, resinas etc., dignas de estudio para su utilización en forma industrial.

*FECULAS*:- Entre las numerosas plantas indígenas que se podrían utilizar para un trabajo industrial en gran escala, citaré solamente las tres principales: Yuca (*Manihot utilissima*), el Banano (*Musa paradisiaca*) y la Papa (*Solanum* dif. var. indígenas, en especial la *S. andigenum*).

*CONDIMENTOS*:- La Vainilla (*Vanilla odorata, V. planifolia* etc.), la Canela (*Nectandra* sp. y posiblemente *Cinnamomum zeylanicum*), el Achiote (*Bixa orellana*), los Oreganos (*Micromeria obovata, Origanum vulgare*, etc.) los clavos (*Caryophyllus aromaticus, Eugenia aromatica*), muchísimas nueces y almendras, como el Tocte (*Juglans honorei*), la nuez moscada (*Myristica fragrans*), el Marañón (*Anacardium occidentale*) y las pimientas (*Piper nigrum, Capsicum* sp.) etc., etc., son todos, cultivos que tendrían éxito en diferentes zonas del Ecuador y que, con muchas otras plantas de esta naturaleza podrían intentarse en una forma comercial.

*MADERAS*:- Una gran riqueza inexplotada encierran los bosques ecuatorianos, en donde centenares de especies de maderas de todas clases, desde las más finas para ebanistería hasta las más corrientes para usos industriales, constituyen una reserva para el futuro, cuando fuertes compañías puedan establecer una explotación metódica y científica y realizar cultivos de determinadas especies, que hoy se encuentran diseminadas. Para la exportación ha tomado auge, durante los últimos quince años el "balso" (*Ochroma* sp.), la madera más ligera y suave que se conoce y que tiene múltiples aplicationes industriales.

DIRECCIÓN GENERAL DE AGRICULTURA,
QUITO, ECUADOR.

LLEWELYN WILLIAMS: **The Phytogeography of Peru**:- The Republic of Peru has three main physiographic zones, characteristic of the western countries of South America within the tropics, namely: 1) *La Costa*, a narrow, arid, coastal plain with tributary mountain valleys; 2) *La Sierra*, the high Andean ranges varying in width between 200 and 250 miles; and 3) *La Montaña*, a region of dense forest beginning at the tree line upon the eastern slopes of the Andes and extending eastward into the tropical lowlands of the interior.

The Peruvian vegetation is divided in the following manner by WEBERBAUER, from whose works I have freely drawn:

*The Coast*:-

1) The Coastal region of desert and lomas, with a flora which shows decided relationship to the richer flora of the western slopes. The formations belong partly to the periodically vegetating type of the lomas, mainly herbaceous, and in part to the continuously vegetating one, as found along the wet sea cliffs and in river-bank brushwood.

2) The northern coastal region of deserts and semi-deserts. The seashore is covered at favorable places by halophytic formations, consisting of woody species such as *Cryptocarpus pyriformis, Prosopis chilensis, Capparis scabrida, Capparis avicennifolia* and *Acacia tortuosa*. Outside the *Cryptocarpus* groves the prevailing vegetation includes *Capparis crotonoides, Scutia spicata, Grabowskia Boerhaavifolia* and *Cordia rotundifolia;* also grasses, herbaceous plants, mostly annuals, and some tuberous plants.

3) The northern coastal region of rainy-green park landscape, confined chiefly to the Department of Tumbez. The most widely distributed vegetation here consists of herbs, columnar cacti and scattered or stands of woody plants. A typical tree is *Loxopterygium huasango;* also of common occurrence are: *Caesalpinia corymbosa, Bursera graveolens, Capparis scabrida, C. mollis* and *Prosopis chilensis*. Representative of rainy-green shrubs are: *Coccoloba Ruiziana, Mimosa acantholoba, Pithecolobium excelsum* and *Cordia rotundifolia*. Common cacti include *Cereus macrostibas* and *C. Cartwrightianus*, while herbaceous vegetation is mainly of small annual grasses.

*The Sierra*:-

This embraces the western slopes, the high Andean regions and the inter-Andean valleys.

4) The western Andes of southern Peru might be called the zone of *Franseria* and tola (*Lepidophyllum*) shrubs. This is marked not only by climatic and botanical peculiarities but also by orographic features - wide plateaux, high volcanoes and steep-walled canyon valleys. Four belts

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PLANT FORMATIONS OF PERU:-

1. Mixed river bank bushwoods of the coast, including agricultural areas.

2. Lomas of the coast.

3. Distant, evergreen shrubs and low trees nourished by ground water. Herbs absent, bare soil between the woody plants. Cacti absent.

4. Open xerophytic vegetation of cacti, rainy-green shrubs, etc. No trees.

5. Mesothermal rainy-green grass steppes with scattered (mostly rainy-green or periodic) shrubs. Cacti (at least columnar ones) absent.

6. Microthermal tola heath alternating with typical high Andean formations. *Lepidophyllum quadrangulare* predominant below, *L. rigidum* in highest parts.

7. Typical high Andean formations. Many cushion- and rosette-shaped plants. Some procumbent dwarf shrubs. Erect shrubs rare or absent.

8. Rainy-green wood formations (mostly shrubwoods), transitional between macrothermal and mesothermal vegetation, often with much grass and in places alternating with rainy-green grass steppe. Cacti rare or absent.

9. Microthermal grass steppe, evergreen or nearly so. Shrubs rare or absent.

10. Macrothermal subxerophytic evergreen bushwoods (consisting of high schrubs and low trees), alternating with evergreen grass steppes.

11. Evergreen woods of foggy region, unbroken by grass steppe or nearly so.

12. Tropical rain forest or hylaea.

COLOMBIA
ECUADOR
BRAZIL
PERU
BOLIVIA
PACIFIC OCEAN
CHILE
R. Napo
R. Tigre
R. Amazon
R. Zamora
R. Santiago
R. Morona
R. Pastaza
R. Chambira
R. Marañon
R. Huallaga
R. Ucayali
R. Javary
Madre De Dios
Lake Titicaca
MOLLENDO
TACNA
80
75
70
0
5
10
15
20
J.J.J.
1
2
3
4
5
6
7
8
9
10
11
12

may be distinguished: desert region (alt. 500-2600m.); herb-poor region of columnar cacti and *Franseria fruticosa* (max. alt. 3400-3600m.); mesothermal region of tola heath (max. alt. 3800-4000m.); and microthermal or high Andean region of tola heath (upwards of 3800-4000m.).

5) The western slopes of the Andes between the Río Grande system and the Río Moche. Because of the less arid climate the western Andean slopes of central Peru have a richer and more equalized flora than the southern region. In the lower altitudes columnar cacti and other evergreen xerophytes are dominant, while at higher elevations perennial grasses are important elements of the main formation. In between the cactus and grass belts there is an intermediate zone, into which isolated cacti penetrate from below and perennial grasses from above. Within this intermediate zone there is evidently a limit between the two regions, which in central Peru generally lies between 2800 and 3000m., and which perhaps coincides with the frost limit. Up to this elevation are found some of the larger woody plants of the coastal flora - *Schinus molle*, *Carica candicans* and *Caesalpinia tinctoria.*

6) The Puna of central and southeastern Peru. The name puna is generally applied to the region above the limit of agriculture, with an elevation ranging from 3800 or 4000m. to the highest summits. The great majority of puna plants are perennial herbs - *Calandrinia acaulis*, *Liabum bullatum*, *Plantago rigida*, *Lucilia tunariensis*, *Aretiastrum Aescheronianum*, *Merope aretoides* and *Distichia muscoides*, and species of *Nototriche*, *Hypochoeris*, *Azorella*, *Pycnophyllum*, *Werneria* and *Senecio*. Woody plants are evergreen, with knotted, twisted branches and are often leafless. Typical shrubs are species of *Escallonia*, *Gynoxys* and *Polylepis*, while the tallest tree is the bromeliad, *Puya Raimondii.*

7) Inter-Andean valleys south of 11° Lat. In descending these valleys a gradual change is noted in the vegetation, determined partly by the moister climate and depending in part on the increasing depth of the valleys. In the upper reaches of the slopes the vegetation is hygrophilous, the periodicity of the vegetation gradually disappears, shrubs in the grass steppes become more numerous, finally forming evergreen stands independent of watercourses and alternating with patches of grass steppes. In the lower part of the slopes the vegetation is xerophilous, characterized by columnar cacti, herbs and woody plants bearing green leaves only during the short wet season. In the deep valley floors a savanna-like character predominates, where grasses and stunted trees abound.

8) Inter-Andean section of the Huallaga river. In the upper reaches grass steppes and scattered shrubs prevail, the latter gradually forming continuous stands. Below 3000m. thermophilous xerophytes appear - *Caesalpinia tinctoria*, *Mentzelia cordifolia*, *Fourcroya*, *Cardiospermum*, *Acacia macracantha*, *Jacaranda acutifolia* and various cacti. Below 2800m. *Schinus molle* and *Dodonaea viscosa* are abundant. At 2200m. columnar cacti become dominant, while grasses are represented only by scattered annuals.

9) Inter-Andean valley of the Marañon from its source to 6°30′. In this, the largest of the inter-Andean valleys, a change of vegetation is obtained, as elsewhere, by the increase of the humidity as one proceeds northward. In the uppermost part two areas may be distinguished - the lower characterized by a treeless, herb-poor xerophyte formation (*Cereus* and *Cephalocereus*), and an upper one with a vegetation of grass steppes and scattered shrubs. In the main valley, between 9° and 6°30′S, the lower slopes and valley floor are dominated by a savanna-like xerophyte formation, composed of cacti and rainy-green trees - *Jacaranda acutifolia*, *Cercidium praecox*, *Piptadenia colubrina*, *Caesalpinia corymbosa*, *Banisteria leiocarpa*, *Jatropha Weberbaueri*, *Bombax Ruizii*, etc.

10) The Jalca. This extensive paramo of the north corresponds to the puna of central and southern Peru, but has a lower elevation. The general appearance of the vegetation is dominated by microthermal grass steppes, usually free of shrubs. The flora, especially in the upper altitudes, contains elements reminiscent of the puna, such as *Nototriche*, *Azorella*, *Lucilia*, *Werneria* and *Culcitium*. The vegetation of rocky areas includes shrubs, mostly species of *Ribes*, *Calceolaria*, *Diplostephium*, *Senecio* and *Chuquiragua*. On the moors, besides *Sphagnum*, *Carex* and *Werneria*, are large tufts of a grass, *Danthonia sericantha*, the shrub *Loricaria ferruginea* and species of *Puya.*

11) The western slopes of the Andes between the Río Moche and the Río Sana. This area lies between 8° and 7°S, where the vegetation bears a closer relationship to that of the inter-Andean valleys of the same latitude, and especially those of the north, than to that of the western slopes of central Peru.

12) The western slopes and inter-Andean region of the extreme north, where a line fluctuating between 7° and 6°30′ limits this area to the south. The floristic character of the lower and middle elevations is determined chiefly by certain xerophytes and mesophytes inhabiting exclusively the northern region of Peru and which occur also in Ecuador and Colombia. Representative of these are species of *Capparis*, *Jatropha*, *Elutheria*, *Carica*, *Bombax*, *Cocoloba*, *Bougainvillea*, *Streptosolen*, *Mayepea*, *Stenolobium*, *Cantua*, *Stemodia*, *Cervantesia*, *Schoepfia* and *Amicia.*

*The Eastern slopes:-*

The structure of the mountains on the eastern side of the Andes is more complicated than in the west. This region is divided into two main belts. The first of these is the *ceja de la montaña* (brow of the mountain) with elevations ranging between 1800 and 3600m., as distinguished

from the lower tropical part, called the *montaña*.

13) The ceja de la montaña. Constant fogs characterize the climate of the ceja. Here the predominating vegetation consists of evergreen formations of shrubs and small trees, many with hard, coriaceous foliage, or bush forests of trees which do not attain the dimensions of those found in the tropical rain forest. Furthermore, this region differs from the montaña by the greater abundance of tree ferns, *Ericaceae*, *Lobeliaceae* and *Compositae*, and yields such genera as *Berberis*, *Hesperomeles*, *Ribes*, *Monnina*, *Fuchsia*, *Polylepis*, *Vallea*, *Gunnera*, *Viola*, *Geranium*, *Bomarea*, *Calceolaria*, *Thalictrum*, absent or sparingly represented in the montaña. In the ceja also are the western limits of several genera of ferns and palms, *Eriocaulaceae*, *Monimiaceae*, *Aquifoliaceae* (*Ilex*), *Theaceae*, *Marcgraviaceae*, *Podocarpus*, *Gaiadendron* and *Cinchona*, most *Araceae*, *Orchidaceae*, *Lauraceae*, *Melastomaceae*, *Araliaceae*, *Ericaceae*, *Gesneriaceae* and many other types characteristic of the eastern flora. Another peculiarity is the abundance of epiphytic ferns and flowering plants, as well as lichens and mosses. In areas of drier climate grass steppes alternate with woody formations. Climatically the east is the moistest part of Peru, consequently the vegetation consists mostly of evergreen woody growth.

14) The montaña. The upper limit of this tropical evergreen forest is estimated at 1800m., about as high as tropical agriculture extends. Here the vegetative associations vary greatly - hydrophytic, hygrophytic, subxerophytic and xerophytic types merging one into the other. At many places in the mountains subxerophytic formations prevail, while the low front ranges and the plains to the east are covered with tropical rain forest and matorral. In addition to the floristic differences already discussed between the two belts, certain plants of the montaña extend even into the lower part of the ceja. Thus we find that *Monstera*, *Heliconia*, *Renealmia* and *Costus* have their upper limits between 1800 and 2100m.; *Iriartea*, *Astrocaryum*, *Phytelephas* and *Carludovica palmata* between 1200 and 1500m. In its lower limits the montaña is closely related to the Hylaea, although it exhibits certain types (*Cinchona*, *Bejaria*, *Cavendishia*, *Gaultheria*, *Embothrium*, etc.) that have close affinity with the Andean flora. It also includes immigrants from distant eastern xerophytic or subxerophytic regions, such as *Dilodendron*, *Dictyoloma*, *Luehea*, *Curatella*, *Physocalymma* and *Cybistax*.

*Summary of Botanical Explorations in Peru*:- In 1798 the first volume of RUIZ and PAVÓN's *Flora Peruviana et Chilensis* appeared, and in 1802 Volume II was distributed. In 1829 POEPPIG arrived at Callao and proceeded to Huánuco and later collected in the vicinity of Tocache, Department of San Martín, and Yurimaguas, Department of Loreto, terminating his investigations in 1831. After two years of investigations in northern Bolivia, WEDDELL entered Peruvian territory in 1847 and botanized in the valleys of San Juan del Oro and Sandia, in the Department of Puno, later visiting the region of Titicaca, the valley of Santa Ana and ascended the crater of the volcano Misti. WEBERBAUER arrived in Callao in 1901 and first concentrated his attention to the region of Lima, along the Rimac River, around Matucana, Yauli, Chicla, as far as the silver mine of Arapa (alt. 12,500 ft.). In 1902 he undertook an expedition to the province of Sandia, in the Department of Puno, where he studied the exuberant vegetation of the Cordillera, later descending to the heavily forested region of Inambari, before proceeding to Arequipa. In later years he concentrated his attention to the central and northern part of the Republic, continuing his explorations as far as Yurimaguas and Iquitos, in the Peruvian Amazon. The well known Peruvian botanist, FORTUNATO L. HERRERA, commenced his botanical labors in the Department of Cuzco in 1922, limiting his collections at first to the *Cactaceae*, later extending his efforts to making general collections. Several expeditions have been led by him to the basins of the Urubamba and Apurímac. Dr. HERRERA is the author of "Estudios sobre la flora del departamento del Cuzco" (Vol. 1, Lima, 1930 and Vol. 2, Cuzco, 1933) and of "Catálogo Alfabético de los Nombres vulgares y científicos de Plantas que existen en el Perú", published in 1939 by the University of San Marcos, Lima. The first botanical expedition to Peru sponsored by Field Museum of Natural History, was undertaken in 1922 by JAMES FRANCIS MACBRIDE (author of *Flora of Peru*, now being published by Field Museum), accompanied by WILLIAM FEATHERSTONE. Most of their work was done in central Peru in the highlands around Oroya, San José, Tarma and Huánuco. The following year MACBRIDE, accompanied by BRYAN, of the University of Wisconsin, resumed collecting at Huánuco at the beginning of April, whence they crossed the eastern Cordillera of the Andes, proceeding to Pozuzo. As a result of this expedition about 11,000 specimens were obtained. In 1929-30, LLEWELYN WILLIAMS spent twelve months in northeastern Peru. With headquarters at Iquitos, numerous excursions were made along the Peruvian tributaries of the Amazon as far as the Brazilian frontier. After spending several months in the lowlands of Loreto, he continued his explorations and collections in the forest extending to the highlands of the eastern Cordillera of the Andes. He returned to Chicago in May, 1930, with a collection of 8,200 numbers, 22,500 specimens in all, in addition to 2,154 specimens of wood and other material. Under the auspices of the Smithsonian Institution, KILLIP and SMITH undertook an expedition to eastern Peru early in 1929, proceeding by way of Tarma, Huancayo and explored the margins of Apurímac, also in the Chanchamayo valley, particularly around San Ramón, La Merced and the Perené colony. Following the Pichis trail they reached the

Ucayali, later descending to Iquitos before returning to Yurimaguas and other points on the Huallaga River. Other important investigations and collections include those of JUSSIEU, DOMBEY, TAFALIA, NÉE, POEPPIG, HAENKE, HUBER, FOOTE, GÜNTHER and BUCHTIEN, PENNELL, RAIMONDI, SPRUCE, MATHEWS, TESSMANN, ULE, CARLOS SCHUNKE, OSCAR HAUGHT and KANEHIRA.

In his "Catálogo alfabético de los Nombres vulgares y científicos", HERRERA gives a concise account of the botanical collectors and other naturalists who have made important contributions to the flora of Peru.

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MARTÍN CÁRDENAS: **Aspecto general de la Vegetación de Bolivia:-** Es casi imposible dar una idea general de la vegetación boliviana porque si bien Bolivia es una sola nación políticamente, en cambio desde el punto de vista de la Geografía Botánica, es un conjunto de zonas fitogeográficas muy diferentes. Por esta razón y por la dificultad enorme de los viajes de exploración en este país, su vegetación no está todavía bien determinada, ni definido el endemismo de muchísimas especies, a pesar de que han sido ya numerosas las expediciones botánicas que han trabajado en esta parte de Sudamérica desde fines del siglo XVIII. Entre los exploradores científicos que se han ocupado de la Flora de Bolivia podemos mencionar a los siguientes: TADEO HAENKE, ALCIDE D'ORBIGNY, FRANCISCO J. F. MEYEN, JOSÉ B. PENTLAND, HUGO A. WEDDELL, GILBERT MANDON, HENRY H. RUSBY, MIGUEL BANG, OTTO KUNTZE, OTTO BUCHTIEN, ROB. E. FRIES, KARL FIEBRIG, THEODORO HERZOG, ERIC ASPLUND, ORLAND E. WHITE, los genetistas rusos VAVILOV, BUKASOV, y JUZEPCZUK que estudiaron la biología de la papa en América, luego los cactólogos CURT BACKEBERG, JAMES WEST y J. N. ROSE y finalmente los miembros de la Expedición de recolección de papas del "Imperial Agricultural Bureau" de Cambridge: J. G. HAWKES, E. K. BALLS y BALFOUR GOURLAY.

Por nuestra parte y durante nuestra residencia en La Paz, Potosí y ahora en la Universidad de Cochabamba, hemos recorrido también todos los departamentos de Bolivia habiendo recolectado un material variado que asciende a más de 3,000 especies de plantas.

A continuación trataremos de dar una idea apenas aproximada de la fisonomía vegetal de Bolivia y para esto consideraremos las siguientes regiones geobotánicas: a) Hylea, b) Pampas de Mojos, c) Vertiente Oriental de los Andes, d) Altiplano, e) Valles Mesotérmicos, f) Savannas del Oriente y g) el Chaco.

*Hylea*:- Esta región corresponde a la Zona de las Lluvias Ecuatoriales con una temperatura media de 28°C. y la altura sobre el nivel del mar que fluctúa entre 150 y 200 m. Los lugares incluidos en esta región son las cuencas de los Ríos Beni, Mamoré, Bajo Iténez, Madeira, Abuná, Orton y Madre de Diós. Las especies vegetales propias a esta parte de Bolivia, son: *Hevea brasiliensis*, *Bertholletia excelsa*, *Phytelephas macrocarpa*, *Attalea excelsa*, *Trigynaea periquino*, etc.

*Pampas de Mojos*:- Con la denominación de pampas de Mojos se comprende esos inmensos llanos inundadizos que forman las Provincias de Yacuma, Mojos y parte de Iténez, cubiertos de pasto alto y con pequeñas islas de bosque. En estas pampas que están cubiertas en parte por curiches (pantanos) y lagos, predominan dos árboles: *Curatella americana* y *Tabebuia suberosa*. Las pampas del Departamento del Beni tienen el mismo régimen de lluvias y temperatura que la Hylaea, como que alternan con esta.

*Vertiente Oriental de los Andes*:- Llamamos así a la inmensa zona de los Andes cubierta de las más espectácular e impenetrable formación de bosque que todavía debe contener un sinúmero de especies desconocidas. Esta región podemos subdividirla en dos sub-regiones que conducen insensiblemente desde la "Ceja de Monte" hasta la Hylaea y las Pampas de Mojos. La "Ceja" es una formación húmeda de neblina constante, de lluvias de más de 200 cm. y situada, en pendiente de descenso desde los 3,400 m. sobre el nivel del mar. Esta formación se caracteriza por la presencia de los siguientes vegetales: Helechos arbóreos (*Cyathea cuspidata*), *Ericaceae*, *Myrtaceae*, Musgos, diversas plantas epifitas, *Podocarpus nubigena*, *Oreopanax artocarpoides*, *Clusia pseudomangle*, *Centropogon gloriosus*, *Mutisia Bipontina*, *Tropaeolum Kuntzeanum*, *Melastomaceae*, *Fuchsia*, etc. La segunda formación de la Región Subandina, sería el "Yunga" que a su vez todavía podría diferenciarse en "Medio Yunga" y "Yunga Verdadero". El Medio Yunga desciende desde los 2,800 m. hasta 2,200 m. y es peculiar por el predominio de los helechos arbóreos, *Cecropias* y las *Gramíneaceae* demoninadas "Kuris" (*Guadua*). El "Yunga Verdadero" baja desde los 2,000 m. hasta los ríos que cruzan las gargantas cordilleranas y a esta formación corresponden la "Coca", *Cinchona*, *Ladenbergia*, luego las palmeras: *Iriartea*, *Geonoma* y *Chamaedora* así como el "Palo de balsa" *Ochroma*

*lagopus*, el "Charo" *Gynerium sagittatum*, etc.

*Altiplano*:- Es la Meseta Boliviana situada a una altura media de 3,600 m., con lluvias de Diciembre a Marzo y una temperatura media de 7°C. Esta inmensa llanura alta, de suelo muy alcalino, tiene una vegetación pobre, de arbustos resinosos y almohadillados. Las especies dominantes en la Meseta Boliviana son: la "Tola" (*Lepidophyllum quadrangulare*), la "Yareta" (*Azorella glabra*), luego *Adesmia spinosissima*, *A. patancana*, *Baccharis microphylla*, *Verbena minima*, *Margyricarpus setosus*, *Eragrostis lurida*, *Hoffmannseggia Doehlii*, *Balbisia Meyeniana*, *Opuntia Pentlandii*, etc. La Meseta Boliviana comprende parte del Departamento de La Paz y casi la totalidad de los Departamentos de Oruro y Potosí.

*Valles Mesotérmicos*:- Damos esta denominación a los llanos intercordilleranos de poca extensión que se encuentran en los Departamentos de Cochabamba, Chuquisaca y Tarija a una altura media de 2,000 m. sobre el nivel del mar, con una temperatura anual de 17° C. y la escasa precipitación de 400 a 500 mm. En estos valles relativemente modernos y formados por el material cordillerano de erosión, encontramos los siguientes vegetales: "Molle" (*Schinus molle*), "Chirimolle" (*Fagara coco*), "Tipa" (*Tipuana speciosa*), "Yacón" (*Polymnia edulis*), "Pino" (*Podocarpus Parlatorei*), "Aliso" (*Alnus jorullensis*), "Algarrobo" (*Prosopis juliflora*), "Chinchercoma" (*Mutisia viciaefolia*), "Orkokaralahua" (*Carica lanceolata*), luego *Parosela*, *Gunnera*, *Schinopsis*, *Solanum*, *Cereus*, *Echinopsis*, *Aspidosperma*, etc.

*Savannas Orientales*:- Es de advertir que este término así como otros utilizados en la Geografía Botánica de Sudamérica, requieren una revisión porque las formaciones botánicas de este continente, obedecen en su denominación a un concepto panorámico más que a su verdadera composición. Con todo el Dr. HERZOG emplea la denominación de savanas para referirse a los llanos que circundan la ciudad de Santa Cruz y se extienden al norte hacia a las Provincias de Velasco y Ñuflo de Chávez, y hacia el sud y sudeste hasta la Cerranía de Chiquitos. Esta zona corresponde al sistema de las lluvias de verano con una precipitación media de 1,400 mm. y una temperatura anual media de 26°. La especie dominante en estas regiones es la palmera "Totai" (*Acrocomia totai*); corresponde también aquí la única *Cycadaceae* de Bolivia: *Zamia Brongniartii*. En las vecinidades de San José de Chiquitos y Roboré existe la formación típica llamada "abayoi" que se compone de árboles y arbustos bajos diseminados en medio de los pajonales. La vegetación de estos lugares se fisonomiza por las siguientes especies: *Taccarum Weddellianum*, *Acrostichum danaeafolium*, *Gomphrena decumbens*, *Ananas comosus*, *Piper pampanum*, *Anemopaegma glaucum*, *Sebastiania serrulata*, *Dichromena ciliata*, *Croton roborensis*, *Cochlospermum trilobum*, *Typha latifolia*, *Celtis iguanaea*, *Croton Cardenasii*, *Terminalia fagifolia*, *Bletia catenulata*, *Spiranthes elata*, *Stenorrhynchus macranthus*, etc.

*El Chaco*:- Esta zona se extiende al sud de la Cerranía de Chiquitos y continúa hasta la Argentina. Comprende en Bolivia la Provincia Cordillera del Departamento de Santa Cruz, la Provincia Azero del Departamento de Chuquisaca y la Provincia Gran Chaco del Departamento de Tarija. Su régimen de lluvias apenas pasa de los 500 mm. con una temperatura media de unos 22° a una altura sobre el nivel del mar de 250 m. por término medio. La vegetación del Chaco está particularizada por el "monte" como formación predominante, aunque también existen en esta región, algarrobales o matas claras, luego los pajonales y los palmares. El "monte" es un bosque bajo xerófilo y espinoso constituido principalmente por: *Capparis Tweediana*, *C. retusa*, *C. salicifolia*, *Cercidium praecox*, *Heimia salicifolia*, *Celtis tala*, *Ruprechtia triflora*, *Bougainvillea infesta*, *Janusia guaranitica*, *Zizyphus mistol*, *Gourliaea decorticans*, o "Chañar", etc. Los algarrobales están formados esencialmente por el "Algarrobo" (*Prosopis juliflora*) luego por los quebrachos: *Schinopsis Lorentzii* y *S. Balansae* o quebrachos colorados y *Aspidosperma quebracho-blanco* o "quebracho blanco" así como el "Algarrobillo" *Caesalpinia melanocarpa* el "Palo Santo" *Bulnesia Sarmienti*, etc. El suelo de los "montes" contiene las "Caraguatas": *Bromelia serra* y *B. Hieronymii*. En los pajonales se destacan los árboles barrigudos o "Toborochis" *Chorisia ventricosa* así como el pequeño arbusto de raíz gigantesca llamado "Cipoy" *Jaccaratia Hassleriana*. Finalmente los palmares que son a veces extensos y monoespecíficos están compuestos por el "Caranday" *Copernicia cerifera* y otra palma pequeña de hojas abanicadas *Trithrinax schizophylla*.

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**MARTÍN CÁRDENAS: Recursos Naturales del Reino Vegetal en Bolivia**:- Desde el punto de vista económico, Bolivia es un país esencialmente minero y en general de vida colonial porque no ha exportado sino materias primas naturales. En los primeros años de su vida republicana, exportó enormes cantidades de "quina" (*Cinchona* bark) hasta que se hicieron plantaciones racionales de los árboles de Quina en Asia. Más tarde con el gran desarrollo que adquirió la industria gomera en el Mundo, Bolivia tuvo un auge de exportación de la

"siringa" (rubber), comercio que también cayó a causa del cultivo grande que se hizo de los árboles de la Goma elástica en la India oriental.

Es curioso observar que muchos productos vegetales originarios de Sudamérica como la quina, la goma, la coca, la yuca (mandioca), etc., no se cultiven en su patria sino en pequeña escala, correspondiendo el gran abastecimiento mundial de estas materias primas al Asia. Quizá la razón de esta paradoja está en la explotación agrícola más barata y el transporte marítimo más fácil que caracterizan al Asia insular frente a la América del Sur, continente poco poblado, con sus regiones tropicales todavía inaccesibles y de penetración difícil por su natural topografía y su carácter malsano. Sudamérica es pues sin duda una tierra de reserva agrícola para el futuro y en este sentido la guerra actual nos deja vislumbrar una manifiesta lucha por la posesión del Asia entre los países totalitarios y las democracias que siempre han de preferir ese continente para la extracción de las materias primas tropicales. Con todo, si el Asia quedara bajo el control del Japón y los demás países del Eje, a Estados Unidos no le quedará más recurso que preparar en América latina su abastecimiento con goma, quina y otros productos aunque sea a un gran costo de explotación.

Bolivia en la actualidad no vive sino de la exportación de minerales y concretamente del estaño, circunstancia que justifica su descuido por la Agricultura. Por otra parte, la técnica agrícola en Bolivia hasta hace poco ha estado en manos del indio, que será un factor étnico de gran valor si acaso se lo incorpora a la economía agrícola de la nación entrenándolo en las prácticas modernas del cultivo. La Minería Boliviana pudo encargarse de derivar sus ganancias al incremento agrícola para garantizar la vida del país en un futuro tal vez no improbable de menor demanda de minerales. Felizmente, en estos últimos años hay algún interés cultural por la agricultura en la Universidad de Cochabamba que cuenta con la única Escuela Superior Agronómica de Bolivia, mientras que políticamente el Supremo Gobierno ha suprimido más bien el Ministerio de Agricultura desde 1940. La Escuela de Agricultura de Cochabamba se está interesando actualmente en organizar trabajos de experimentación en la genética y fitopatología de la papa y el maíz que son dos productos bolivianos de importancia económica.

Ahora, para dar una somera idea de las fuentes naturales de orden vegetal que posee Bolivia en potencia, para un futuro agrícola de trascendencia, examinaremos las siguientes regiones fitogeográficas: Hylea, Pampas de Mojos y Yacuma, Llanos orientales, Valles mesotérmicos y Altiplano.

La Hylea o Región Amazónica Selvática, que comprende los Departamentos de Pando, Beni y La Paz, cuenta todavía con una abundante reserva de árboles de goma y "castaña" (*Bertholletia excelsa*) explotables, fuera de un sinúmero de árboles madereros aún desconocidos en los mercados mundiales. A esta misma zona corresponde la Provincia de Caupolicán del Departamento de La Paz que es de una riqueza vegetal fantástica, ya que esta parte de Bolivia es una verdadera síntesis de los tipos de zonas más valiosas de todo su territorio, pues, en Caupolicán existen quina, grandes pastales para la crianza del ganado, regiones magníficas para el cultivo del café, cacao, etc. y finalmente petróleo. Esta provincia no está sino a unos dos grados geográficos de La Paz y limita por otra parte con una región del Perú próxima a la costa. Esta hermosa y rica provincia boliviana tiene un gran porvenir agrícola porque además de su proximidad relativa al Altiplano no es tan malsana como la parte baja de la Hylea.

Los Llanos de Yacuma y Mojos, cubiertos de pasto que hacen horizonte por la inmensidad impresionante de la "pampa", pueden sustentar la crianza de cantidades ilimitadas de ganado vacuno; pero sin embargo a causa de su alejamiento de las vías de comunicación accesibles del país, sus inundaciones frecuentes y sus condiciones de salubridad, todavía representan una zona sin valor actual. En estas pampas abundan dos árboles medicinales: la "Copaiba" (*Copaifera*) y el "Chiriguana" (*Simarouba glauca*), teniendo la corteza de la última especie un gran valor en el tratamiento de la disentería en estos lugares.

Los Llanos Orientales comprenden las savannas del Departamento de Santa Cruz y parte del Departamento de Cochabamba. Las provincias del norte de Santa Cruz: Ñuflo de Chávez, Velasco, Sara e Ichilo contienen una gran reserva de maderas valiosas como la "Mara" (*Swietenia* ?), el "Cuchi" (*Astronium urundeuva*) etc. y además inmensos palmares sobre todo de "Cusi" (*Orbygnia phalerata*) que produce un aceite fino. Los llanos orientales de Cochabamba que comprenden Aiquile y Mizque pueden servir para cultivos extensos de algodón y árboles madereros. Los llanos orientales de Bolivia en un futuro quizá no muy lejano, se conectarán con el planalto meridional del Brasil que es considerado hoy como una de las regiones sudamericanas de mayor florecimiento económico juntamente con la planicie platina y los valles de Chile.

Los Valles Mesotérmicos que se encuentran en las inmediaciones de las ciudades de Cochabamba, Sucre y Tarija, son comparables a los valles de Chile en su producción agrícola aunque tienen un clima muy benigno, más uniforme y seco. Estos valles están caracterizados por su gran producción de maíz. Las variedades de maíz que se cultiva en estas regiones, se mantienen desde tiempo inmemorial sin que se conozca su origen; pero con todo, exceptuando las variedades: "Uchuquilla" y "Pisankalla" que son de granos duros y aperlados, las demás son de tipo amiláceo muy dulce como el "Chuspillo" (maíz para tostado), el "Willcaparu" (para chica), el "Culli" (púrpura). Además existen dos variedades más que son el "Amarillo" y el "Blanco" que parecen haber sido introducidos de otras partes.

En general los maíces bolivianos por su carácter blando y amiláceo, no resisten el almacenaje prolongado, y quizá entonces haya que crear una o más nuevas variedades de carácter económico. Los Valles Mesotérmicos se prestan también al cultivo frutícola sobre todo del duraznero que produce en Cochabamba una fruta deliciosa.

El Altiplano se caracteriza por su enorme extensión superficial, su gran población indígena y su producción especial de papas, oca, quínoa, kañahua, etc. Las porciones planas del Altiplano tienen un terreno de alta concentración salina y requieren drenajes profundos para su adaptación al cultivo y por esta razón los mayores cultivos de papas están en las faldas de los cerros o en terrenos no arcillosos. El problema genético de la papa en Europa ha convertido la patria de origen de esta planta en un centro de gran interés actual como lo demuestran las expediciones venidas a Bolivia en los últimos años, de Rusia, Alemania, Inglaterra y Suecia. En las numerosas variedades de papas de Bolivia, todavía será posible descubrir factores genéticos que permitan resolver algunos problemas como la resistencia a la helada, a la *Phytophthora*, la producción prematura, etc., ya que las variedades europeas no dan más lugar al desdoblamiento de nuevos caracteres porque como afirma el genetista ruso S. BUKASOV están "ahogadas en su propio jugo".

El Altiplano puede convertirse en una región productora de papa, de importancia en Sudamérica, en vista de las grandes posibilidades genéticas que seguramente encierran las especies cultivadas y silvestres de papas bolivianas. Además el problema de la conservación de la papa en relación al proceso admirable de preparación del "chuño", debe ser estudiado.

La quínoa (*Chenopodium quinoa*), se cultiva todavía en pequeña proporción en el Altiplano, aunque por su valor nutritivo debiera generalizarse su consumo en diversas formas dietéticas. Existen unas doce variedades de quínoa cuyo estudio abre las probabilidades para determinar el origen de esta planta y para su mejoramiento genético. Otra planta de esta misma familia y que produce unos granos de gran poder alimenticio, más estimados que los de la quínoa, es la "Kañahua" (*Chenopodium palidicaule*), que desgraciadamente se cultiva aun en menor escala que la quínoa.

Ahora, refiriéndonos a la vegetación silvestre del Altiplano, no dejaremos de mencionar una especie de algún porvenir económico para la vida misma de las ciudades altas de Bolivia como Oruro, La Paz y Potosí, la "Yareta" (*Azorella glabra*) que al igual que otras especies altiplánicas adopta una morfología almohadillada o de "mounds" por su acomodación a una vida en sitios altos (4,000 m.), fríos y áridos. Es una especie muy resinosa que tratada por una gasolina de poca densidad dá una resina y un residuo de celulosa aprensable en briquetas que constituyen un precioso combustible mientras que la resina por destilaciones fraccionadas produce una infinidad de substancias susceptibles de aprovechamiento futuro.

Para terminar esta breve reseña de las fuentes naturales de orden vegetal en Bolivia, nos referiremos a algunos productos explotables con indicación de su origen:

*Quina* (*Cinchona calisaya*):- Silvestre en las cuencas de los Ríos Coroico, Mapiri, Bopi, Tipuani y Challana a alturas de 800 a 1800 m. sobre el nivel del mar. Cultivada en San José y San Carlos de Mapiri, luego en Pararani, cerca de las anteriores regiones y en Quilo-Quilo de la Provincia Nor-Yungas (La Paz). La quina puede cultivarse en el Chimoré (Cochabamba), región con camino de autos a 48 horas de viaje de Antofagasta.

*Guapi* o "Cocillana bark" (*Guarea Rusbyi*):- Silvestre en el Bajo Río Beni a partir de Guanay (La Paz).

*Matico* (*Piper angustifolium*):- Silvestre en Yungas de La Paz.

*Achiote* (*Bixa orellana*):- Silvestre en abundancia en Charagua (Santa Cruz) y Yungas de La Paz y Cochabamba.

*Ipecacuana* (*Cephaëlis ipecacuanha*):- Silvestre en el Alto Iténez sobre la frontera del Beni y Santa Cruz con el Brasil.

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CARL SKOTTSBERG: **The Falkland Islands:-** The Falkland Is. consist of two large (West and East F.) and numerous smaller islands, the total area estimated at about 16380 sq. km. Their distance from South America is about 500 km. They are continental, and an upheaval of 200 m would unite them with Patagonia; recent subsidence is indicated by drowned river valleys forming conspicuous creek systems. Geologically, they differ from the opposite coast of South America. On an Archaean foundation, barely exposed in two places in West F., rest Devonian sandstones and quartzites, as a rule greatly disturbed and raised to form several ranges of hills topped by very hard, light grey quartzite outcrops. South of the broad folding zone forming the northern half of East F. the Devonian strata are overlayered by undisturbed Permo-carbonian beds, the plain of Lafonia. The highest mountain in West F. is Mt. Adam, 700 m, in East F., Mt. Usborne, 683 m.

The Andean glaciation did not reach Falkland, where all signs of ice action are wanting. The so-called stone-runs or stone-rivers, which form a network on the hill-

sides and long streams of boulders in many of the valleys bear witness of a "subglacial" period of solifluction. With an increased precipitation the soil, saturated with water, slowly slid down the slopes carrying accumulations of quartzite boulder, which were exposed when the finer particles were washed out. The blocks are very resistant to weathering processes.

The climate is of a pronounced oceanic type with cool summers (aver. Dec.-Feb. 9.7°C.) and mild winters (aver. June-Aug. 2.5°C.), but slight frosts may occur almost any month, though quite exceptional during the summer. The annual precipitation ranges from 600 to 700 mm; no season is dry, and one may count with about 250 days of rain or snow. A snow cover does not remain for any considerable length of time. Gales are very frequent, and calm, sunny days rare. It is an ideal climate for the formation of peat, to which all the leading plant communities give rise, and peat is the only fuel in the islands. Life conditions are much the same as in the islands in the North Atlantic, the Faeroes, Orkney and Shetland Is.

No tertiary deposits occur, so that we do not know if the Magellanian *Nothofagus*-flora ever inhabited Falkland. Indications of a warmer preglacial climate are not altogether lacking; subfossil remains of at least 2 conifers, most likely identical with species still living in South Chile, including trunks and large quantities of pollen, have been discovered, overlaid by the old sliding soil from the subglacial period. During this the forests, which perhaps did not cover the islands, disappeared, but we have no reason to believe that the flora as a whole was exterminated. It is poor in species, the phanerogams numbering about 145, the pteridophytes 15. Among the former 15 species, one belonging to a monotypic Cruciferous genus, are endemic, but all show the same relations, and nearly all the non-endemic species, including the pteridophytes, belong to the Magellanian flora; some do not, however, reach as far south as West Patagonia or Fuegia. These Magellanian species belong to the rain forests, the bogs, and the coast and mountain heaths. Two sources of origin can be distinguished: the old Antarctic flora, now scattered over the circumpolar Subantarctic zone, and the Andean. More than 40 Subantarctic species are found in Falkland; among the more important are *Blechnum penna marina, Schizaea fistulosa, Lycopodium magellanicum, Agrostis magellanica, Deschampsia antarctica, Poa flabellata, Festuca erecta, Oreobolus obtusangulus, Uncinia brevicaulis, Carex trifida, Gaimardia australis, Juncus scheuchzerioides, Marsippospermum grandiflorum, Rostkovia magellanica, Enargea marginata, Astelia pumila, Colobanthus crassifolius* and *subulatus, Caltha appendiculata* and *sagittata, Ranunculus acaulis* and *biternatus, Drosera uniflora, Crassula moschata, Acaena adscendens, Gunnera magellanica, Schizeilema ranunculus, Azorella selago, Gaultheria antarctica, Veronica (Hebe) elliptica, Lagenophora nudicaulis* and *Abrotanella emarginata*. Some Andean genera with representatives in the islands are *Cortaderia, Sisyrinchium, Asarca, Chloraea* and *Codonorchis, Calandrinia, Hamadryas, Bolax, Pernettya, Calceolaria, Aretiastrum* (*Valeriana*), *Baccharis, Chevreulia, Chiliotrichum, Nassauvia, Perezia, Leuceria* and *Troximon*, and the species of wide-ranging genera like *Hymenophyllum, Trichomanes, Polystichum, Gleichenia, Poa, Carex, Luzula, Stellaria, Draba, Oxalis, Viola, Epilobium, Euphrasia, Plantago, Galium, Aster, Erigeron, Senecio, Hieracium*, or *Hypochaeris* are identical with or closely related to Andean species. A number of bipolar forms are also found, all belonging to southern South America. Bryophytes, especially mosses, and lichens are numerous and many species have been found only in Falkland, but several of these will probably be discovered in Fuegia, or South Georgia, or Antarctica. The fungus flora is little known. The marine macroflora is luxuriant and fairly well known.

Perhaps the most striking feature of Falkland scenery is the total absence of trees. Experiments have been made to introduce a number of species, both Magellanian and European, but the efforts have not been very serious. Dr. BROCKMANN-JEROSCH regarded the islands as situated outside the polar tree limit, but the experiments, such as they are, have shown that *Nothofagus betuloides* and *Pinus silvestris* and *nigra* will grow there, if effectively sheltered from the wind, either by a wall, or by sufficiently high hills. As soon as they rise above shelter, the shoots are killed. I think it will be possible, if the right kinds are chosen, to create small forests in some valleys in West. F.; *Pilgerodendron* (*Libocedrus*) *uviferum, Nothofagus antarctica, Drimys Winteri* and *Maytenus magellanica* should be tried, as also pines and species of *Betula* and *Sorbus*. Of native shrubs, only two rise much above the ground, *Veronica elliptica*, which is coast-bound, and *Chiliotrichum diffusum*, which often fringes the streams. The common gorse (*Ulex europaeus*), which is becoming naturalized, gives us a hint of what kind of shrubs would be of value. Willows do well. The native flora is composed mainly of low-growing or trailing dwarf shrubs, numerous graminoid plants, and chamaephytic, often mat- or cushion-forming perennials, with few exceptions evergreen; geophytes and annuals are very few. Collecting can be pursued the year round, but the flowering season is summer.

*Principal plant communities*:- Although the islands have been used for grazing only during the last 200 years, and there is no agriculture worth mentioning, it is evident that the vegetation has undergone notable changes. This is particularly true of the coastal belt where in older time the mighty tussock grass, *Poa flabellata*, quite dominated the scenery with its almost pure association. Cattle, introduced in the middle of the 18th century, multiplied and ran wild, forming very large herds, and after

they had been killed off and sheep-farming on a large scale introduced during the latter part of the 19th century, the tussock, which gave a vivid green hue to the islands, was rapidly becoming destroyed and now survives only on some steep, rocky shores and on some small, unstocked islands. *Poa flabellata* is a halophyte and will not thrive very far from the sea. The giant sedge *Carex trifida* has shared its fate. The shore is now inhabited by heath associations, where, besides the common species, *Perezia recurvata, Nassauvia Gaudichaudii, Oxalis enneaphylla, Calceolaria Fothergillii* and *Senecio Darwinii* become conspicuous. At the water's edge *Apium australe, Colobanthus subulatus, Crassula moschata* and *Plantago barbata* are found, on sandy beaches *Agropyrum magellanicum, Festuca arenaria* and *Senecio candidans.*

The inland associations belong to the oceanic heath series, running from grass heath (sometimes, but less appropriately called meadow) through Ericaceous heath to bog and swamp. From the top of any elevated hill one is as a rule able to overlook the whole range of associations, distinguishable by their different colors.

The dominant color of the ridges and slopes, if not overgrazed, is a dirty yellow, the *Cortaderia* Ass. It never turns into a fresh green; *C. pilosa* is a coarse tunicate gras, about 3 or 4 dm high when well developed and growing in thick bunches. The few green blades are hidden in the mass of perennating dead ones. This association is developed on all non-swampy soil, especially where the subsoil is composed of finegrained material. The best grass heaths were observed in Lafonia. Other grasses and a number of herbs form a carpet between the *Cortaderia* tussocks, for example *Agrostis magellanica, Deschampsia flexuosa, Cares caduca, Acaena adscendens, Blechnum penna marina* and other species of the Ericaceous heath.

The *Empetrum* Ass. with *E. rubrum* as the leading species is second in importance, covering the stony ridges and hill sides and contrasting by its dark brown color. Additional dwarf shrubs are *Pernettya pumila, Gaultheria antarctica, Baccharis magellanica, Myrteola nummularia* and *Rubus geoides. Agrostis magellanica, Deschampsia flexuosa, Festuca erecta* and *Luzula alopecurus* are generally seen, and dense carpets of *Azorella filamentosa* and *lycopodioides, Chevreulia stolonifera, Drapetes muscosus* and *Blechnum penna marina;* among the accessory species are *Chloraea Gaudichaudii, Enargea marginata, Gentiana magellanica, Oreomyrrhis andicola, Taraxacum magellanicum* and *Troximum pumilum,* and a search will as a rule reveal the minute Santalaceous hemiparasite *Nanodea muscosa.* To the same assemblage belong some of the few showy species, *Codonorchis Lessonii, Sisyrinchium filifolium* and *Leuceria suaveolens.*

The stone-runs may be quite barren, covered only with lichen associations, or have patches of soil supporting fragments of heath, either *Cortaderia* or *Empetrum* or a mixture of both. Rooted deep down between the angular quartzite boulders grow *Nassauvia serpens,* perhaps the finest of the Falkland endemics.

The quartzite outcrops along the ridges are as a rule accompanied by a type of *Empetrum* heath characterized by the abundance of clumps of the stiff, shiny *Blechnum magellanicum* and the huge, hard cushions of the famous "balsam-bog", *Bolax gummifera.*

The valley bottoms, in many places impassable, are occupied by a variety of moor communities, not rarely extending up the slopes. The vivid green *Astelia* Ass. is the nearest subantarctic equivalent to the oceanic "high moor" of north west Europe. It is very important in Falkland. In contradistinction to all northern bogs, peatmosses (Sphagna) are of no importance or even missing, being replaced by the Phanerogams, forming an undulating surface of very hard and close, flat cushions, the interior consisting of densely packed dead leaves and living roots, this spongy mass soaking up and retaining the rain water. Besides *Astelia pumila, Oreobolus obtusangulus, Gaimardia australis* and *Caltha appendiculata* are the most important species, but *Abrotanella emarginata* is not uncommon, and trailing dwarf shrubs like *Myrteola* or *Gaultheria* are also found, especially on rising hillocks. A few mosses and hepatics are commonly found in the carpet, and *Drosera uniflora* is rarely absent. The wettest depressions are inhabited by the nearly black rush *Rostkovia magellanica* and filled with aquatic mosses, including submerse Sphagna. In many places wet grass heath, wet *Empetrum* heath, *Astelia* carpets and *Rostkovia* swamp combine to form a complex of associations.

The fresh water flora is poor. There are no lakes in the islands, but numerous small ponds and streams, the latter occasionally the home of interesting submerged mosses and a number of flowering plants in the carpet, as *Gunnera magellanica* and *Montia rivularis.* Stagnant water is very poor all over the Devonian zone, the species most often met with being *Callitriche antarctica, Lilaeopsis macloviana, Myriophyllum elatinoides* and *Scirpus cernuus,* but the waters of Lafonia have a more eutrophic character and harbor a number of additional species such as *Heleocharis melanostachys, Limosella lineata, Litorella australis* and the tall *Scirpus riparius.*

To judge from the conditions in the rainy parts of Tierra del Fuego we would find a lowlying timberline also in Falkland, if these islands were forested, and consequently also an Alpine region. As it is, the stony *Empetrum* heath, where *Bolax* generally becomes conspicuous, runs clear to the highest summits. A scanty Alpine element has been found on the loftiest hills, comprising *Viola tridentata, Hamadryas argentea, Aretiastrum sedifolium,* and *Azorella selago* - one of the leading plants in Kerguelen Island - but only the two last mentioned are confined to the summits.

Above no weeds have been mentioned.

Accidentally introduced species are common in the vicinity of Port Stanley and round the settlements, all situated at the coast; inland are only a few shepherd's houses, and no roads exist along which foreign species might spread, except in the immediate vicinity of the small town. Some species are, however, observed quite frequently in the heath, such as *Aira caryophyllea* and *praecox, Cerastium holosteoides* (*vulgare*), *Poa annua* and *pratensis, Rumex acetosella* (very abundant where the naked peat is exposed after cutting), *Sagina procumbens, Senecio vulgaris* and *Veronica serpyllifolia*, but none of these has altered the aspect of the natural plant communities very much. Some species introduced on purpose have become naturalized: *Ulex europaeus, Bellis perennis* and *Taraxacum officinale*. Some farmers are trying to improve their camp with English grasses and several kinds of clover, so that, eventually, parts of the camp will be turned into artificial pasture; the *Cortaderia* is of little value. Agriculture is very insignificant. Cereals are entirely unsuccessful, oats rarely ripen but are grown as green fodder at the settlements. Potatoes, cabbage, cauliflower, carrots, turnips, spinach, lettuce, parsley and other common vegetables do well, and currants, raspberries and gooseberries have been successful. Many of our common garden flowers grow in the open, but roses are reported to be a failure.

We have no reason to expect any great changes in the aspect of the Falkland vegetation. Sheep-farming is likely to remain the only industry affecting the land, and the islands are not supposed to carry a larger stock than they do now, so that the population cannot be expected to increase very much. It is to be hoped that some "tussock islands" will remain unstocked. The greatest danger comes from the exploitation of the peat. Sufficient bog areas must be set apart if a unique vegetation type is to be spared. Scientifically, the Falkland Islands are important as one of the richest refuges for the Subantarctic flora, and fortunately there seems to be little possibility to "develop" them.

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**WM. C. DARRAH: A Brief Account of the Geology of South America:-** The natural vegetation of every region owes its constitution to the geologic history of the area of its occupance. The interaction of factors such as topography, soils, continental structure, geographic isolation, and climate determine the conditions under which the flora and fauna develop. The continent of South America and its historical relation to the lands of Central America is therefore of great interest to botanist and geologist alike.

South America is approximately 4500 miles long (Long. 70 W.), and 3000 miles wide at the broadest expanse (Lat. 5 S.), with three-fourths of the area within the tropics. The total area is estimated to be 7,000,000 square miles, more than two-thirds being plains under 1000 feet. More striking is the fact that 40% of the area is less than 650 feet in elevation. With respect to isolation from neighboring land masses, only Australia exceeds it.

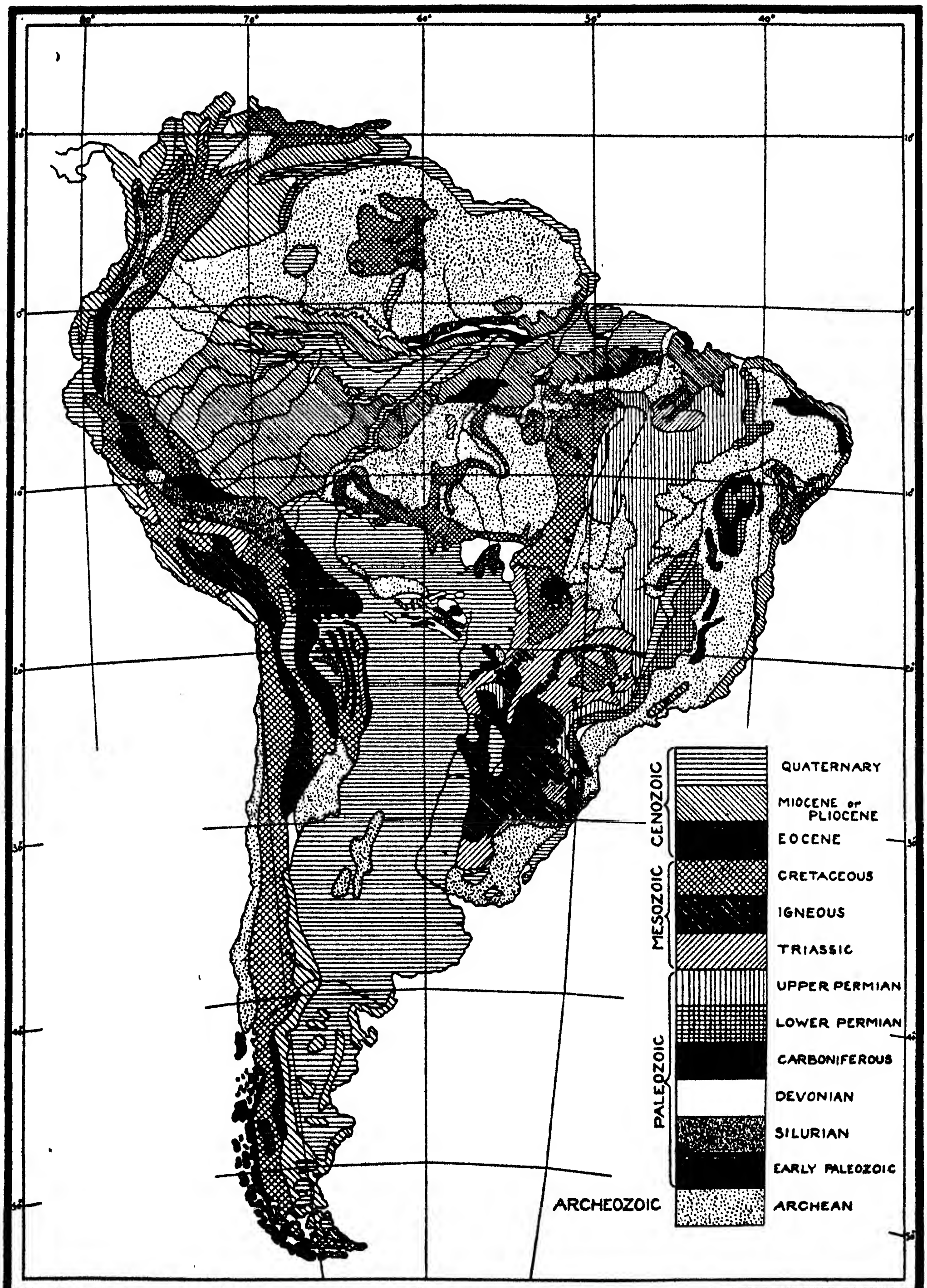
*River Systems*:- The chief river system of South America is the Amazon which drains an area of more than 2,700,000 square miles, that is, approximately 40% of the entire continent. The main stream rises in the Andes of central Peru, and flows across Peru and Brazil, emptying into the Atlantic Ocean on the Equator. Some idea of the magnitude of the stream can be gained from the fact that it is navigable to ocean-going steamers for nearly 2500 miles. There are many large tributaries, the greater number rising in the north, but those of greater volume are affluents from the south. Since the drainage area embraces an equatorial rain belt, the rivers swell commencing in November and increasing steadily until June, thereafter diminishing until October. Alluvial sediments are being deposited and great flat alluvial lands (*igapo*) have developed during recent geologic times.

The second largest river system is the Rio de la Plata which is really only the funnel-shaped receptacle for the Uruguay (including the Paraguay) and Paraná river systems which drain almost 1,200,000 square miles embracing fertile areas of southern Brazil, most of Argentina, all of Paraguay and much of Uruguay and Bolivia. The major affluents of these rivers have a profound effect upon the vegetation of the area.

The Orinoco system in northern South America comprises the third great drainage system. The area of its development includes much of Colombia and Venezuela.

*Chief Physical Features of the Continent of South America*:- The Andes mountain system extends for practically the entire continent along a north-south axis, while a lesser system - the Brazilian Highlands - slopes southwestward (decreasing in elevation progressively). Indeed these two systems have determined the present form and configuration to the entire land mass. A third lesser system, the Guiana Highland, runs east-west between 1° and 8° N. lat. The Andean system attains great altitudes ranging to 20,000 feet for a distance of more than 3,500 miles, within which it has but few passes under 12,000 feet. There are both active and quiescent volcanic cones. Perpetual snow caps many of the peaks even within the tropics.

Between the mountains lies a vast series




A NEW GEOLOGICAL MAP OF SOUTH AMERICA:-

**The map shows the major stratigraphic subdivisions and their characteristic rocks. Jurassic rocks, as such, are not indicated. Instead the Mesozoic "igneous" is used to record both Triassic and Jurassic igneous formations. The age of the igneous rocks of the Andes here called Archean is questionable. — Map drawn by G. W. Dillon, under the supervision of W. C. Darrah.**

of interior plains, mostly under 1,000 feet elevation traversing Brazil and running north-south into Argentina.

Correlated with this great physiographic variety there are marked climatic zones. In the regions of heavy equatorial rains, the precipitation exceeds 80 inches a year, occasionally reaching 105 inches. In these areas luxurious tropical rain forests have developed and maintain themselves. Land clearance for agriculture has proven to be difficult. The dense forest is broken in scattered areas by relatively small grassland areas.

There are, in contrast, extensive regions with less than 10 inches of precipitation, imposing obvious limitations upon vegetation.

The South American continent, then, is characterized by extremes of precipitation, altitude, latitude, temperature and vegetation.

*Relations with Central America*:- The geographic isolation of South America is of special significance when considered in the light of its geologic history. The existing narrow isthmus of land connecting the bulk of Central and South America, together with the existence of a Cordilleran system forming a back-bone, as it were, to the western hemisphere, has obscured the nature of continental development of both Central and South America.

*Chief Geological Features of the Antilles and Caribbean*:- About 1830 HUMBOLDT believed that the two American Continents are dominated by a continuous Cordilleran system, running through North, Central and South America - connecting the whole western border of the hemisphere into one great mountain system. Although this view has been held by some geologists until relatively modern times, certain modifications of the concept must be recognized. Central America is not a structural unit lying between the two great continents of the western hemisphere.

SUESS, about sixty years ago, claimed that the mountain systems of North America run southward into Oaxaca in Mexico, and then, bend eastward across Guatemala and Honduras. A continuation of these systems ran through what are now the Greater Antilles, and swinging southward again along the Lesser Antilles, finally joining with the Andean system of South America in Venezuela.

Later SAPPER showed convincingly that the mountains of northern Central America trend in east-west direction, whereas those of southern Central America have a different strike, a different origin, and a much later (younger) age.

It is not possible to include in this brief discussion more than a general statement of the complex history of Central America. SCHUCHERT (1935, pp. 4-6) gives the following subdivisions of the Antillean-Caribbean area.

*Land Regions*:-

1. Mexico: Mexican plateau, Gulf border, Baja Californica
2. Gulf Coastal Plain of the United States
3. Nuclear Central America and its young foreland (*i.e.*, Oaxaca, Chiapas, Tabasco, Campeche, and Yucatan) (Guatemala, Honduras, Salvador and most of Nicaragua)
4. Greater Antilles and their Bahaman foreland
5. Isthmian link of Panama-Costa Rica-southern Nicaragua
6. Northern South America (Colombia, Venezuela)
7. Oceanic or Carribbee Islands

*Marine Regions*:-

8. Carribbean mediterranean
9. Antillean sea
10. Gulf of Mexico

Region 3 is the ancient and folded mountain land of Central America.

*Structural Elements of South America*:- GERTH has indicated five structural features of the continent. *Guayana* and *Brasilia* are great crystalline Archean complexes accounting for the configuration of the bulge on the north and east. *Cordillera* is the Archean and Algonkian basement complex which, at least in part, later became the foundation for the Andean geosyncline. Smaller outliers of Archean rocks have been exposed by elevation and subsequent erosion. The highlands of igneous and metamorphics to the south of *Brasilia* encloses the lower Paraná Basin. The Amazon river flows between the Brasilia and Guayana complexes.

The extensive *Patagonian* province flanks the Cordillera on the east.

By the end of the Devonian, by far the greater part of South America was land. However, extensive marine inundations occurred in the late Carboniferous and again during the Triassic, Jurassic, and Cretaceous. No early Mesozoic marine sediments have been observed in the Amazon region although there was a Cretaceous transgression.

*The Permo-Carboniferous; Gondwanaland*:- It is generally recognized that during the Permian, probably also in the Carboniferous and Triassic, an essentially homogeneous flora developed in South America, Africa, Australia, New Zealand, and Antarctica. A northern extension occurred in India. This far-flung flora has been interpreted differently by competent observers. The explanations follow two major theories: the land-bridge hypothesis which postulates land connections between the existing continents which thus afforded paths of migration, and the newer continental displacement theory which assumes a large land mass which subsequently fragmented with the fragments drifted apart to form the existing continents. According to the latter view the Permo-carboniferous flora of the southern hemisphere developed before the fragmentation of the greater continent.

The flora associated with the Gondwana sediments is characterized by *Glossopteris*, *Gangamopteris*, *Noeggerathia*, and *Phyllotheca*. The *Glossopteris* Flora occurred in Brazil, Argentina, the Falkland Islands and Antarctica.

In South America as in the eastern hemisphere the *Glossopteris* Flora is found inter-

bedded with glacial deposits - from São Paulo in Brazil and northwestern Argentina to central Bolivia. Similar occurrences have been recognized in the Falkland Islands. It is probable that these represent true interglacial periods.

*The Andes*:- The Andes are narrowest at the southern end and broadest in the central (Bolivian) sector. In Terra del Fuego, their trend is east-west. However, for their great length the trend is north-south with a broad westward arch (about Lat. 18 S.) and thence an eastward arch (Colombia) coinciding with the outline of the northwest coast of the continent. Geographically, the Andean system is divisible into five provinces: Patagonian, South Chilean, Puna de Atacama, the Central Andes (including the Bolivian high plateau or altiplanicie with its interior drainage), and the northern branches.

The geology of the Andes is exceedingly complicated, being composed of sediments and volcanics resting on an Archean complex. The Paleozoic rocks include extensive Cambrian quartzites, Silurian schists, and Devonian sandstones, and conglomerates. These sediments are exposed typically in northern Argentina and eastern Bolivia. The Mesozoic rocks are much more widely distributed (exposed). There are both Jurassic and Cretaceous fossiliferous limestones.

There is some evidence that the so-called "Archean" igneous and metamorphosed rocks of the Andes are largely altered Paleozoic rocks — metamorphosed by Cretaceous batholiths and Paleozoic granites.

The folding and attendant major uplift of the Andes probably commenced during the late Cretaceous and continued with some prolonged interruptions until Pliocene, and perhaps even Recent, times. There are numerous observed uplifted shorelines and raised beaches on the Pacific Coast of South America. Some of these surfaces are late Tertiary but many are Quaternary.

Continental sediments of Tertiary age occur in the depressions and valleys of the Andes, *e.g.*, the Deseado (Oligocene) of Patagonia, and the Casa Mayor (Eocene) of southern Argentina.

The existence of great continental Quaternary deposits in the Amazon Basin and the southern half of the continent is one of the striking features of its geology. There are likewise important Cenozoic sediments in western Brazil, etc.

During the later Cretaceous time the Andes had been elevated, folded and thrust eastward for nearly the full length of the South American continent, and during most of Cenozoic, erosion had resulted in extensive peneplaination in at least the Central Andes. Vertical uplift occurred again during later Cenozoic time, causing a general elevation of this peneplain from 3,000 to 7,000 feet. This high plateau was in turn eroded to a slope with mature topography, and then reelevated during the Pliocene and earliest Pleistocene. Today the dissected erosion surfaces of the old peneplain stand at an average elevation of approximately 12,000 feet, though locally it varies between a low of 6,000 and a high of 15,000 feet. This ancient surface is preserved in the Altiplanicie or high plains of Bolivia. Towards the east great lava flows and lofty volcanic cones have been superposed upon it.

*The Pleistocene*:- Actual glaciation in South America seems to have been confined to the far south, largely in Patagonia. The Andes developed extensive glaciers which in the south descended to much lower levels than present glaciers in the same areas. At times the descension reached the plains and fanned out scattering coarse sediments over the land. The Falkland Islands too were glaciated. Practically nothing is known concerning the Pleistocene of Antarctica, though it is assumed that the ice-sheets were much more extensive than at present.

Loess deposits are widely distributed in a broad transcontinental belt north of the glaciated regions.

Passing mention must be made of the justly famous mammalian fauna from the Argentine Pampas, Ecuador, Bolivia, and cave-deposits of Brazil. The *Mastodon* (spp.) reached South America.

*General Summary*:- Throughout the Cenozoic the lower Amazon region was exposed dry land. A rich flora, essentially identical with the extant vegetation developed. Although the drainage is now Atlantic, during the earlier Tertiary (until the mid-Miocene) it was Pacific. The elevation of the Andes reversed the direction of flow, causing at first numerous lakes which gradually joined into one great lake. Finally an outlet was cut to the Atlantic. On the accompanying map the sediments accumulated in these Miocene lakes are indicated.

The great expanses of land covered by Quaternary sediments provide most of the grassland of South America.

In this brief account of some of the geologic features of South America an attempt has been made to indicate four conditions which have determined the development of the existing flora:-

1. The gross form and configuration of the continent.
2. The antiquity of the lands of the lower Amazon basin and of the flora that developed with it.
3. The existence of Pleistocene glaciation and periglacial phenomena, such as loess deposition, in the southern part of the continent.
4. The prolonged history of the Andes, noting especially the profound influences of its discontinuous elevation upon drainage and climate.

Botanical Museum,
Harvard University.

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FREDERICK HARDY: **The Soils of South America**:- No comparative account of the origin and main features of the soils of South America as a whole, and of their relationships to World Soil Groups seems yet to have been published, except a short article by A. MATTHEI written in 1936 (15). While generalization based on fundamental principles unsupported by detailed field evidence may seem unwarranted, an attempt to bring together some information on South American soils into a comprehensive scheme may stimulate discussion and suggest lines for future study.

*General principles:* The chief agents responsible for the development of soils are (i) climate (rainfall; temperature), (ii) vegetation, (iii) parent rocks, (iv) topography, (v) time. Given sufficient time, climate and vegetation act on rocks to form parent soil materials, with which organic residues become incorporated under suitable topography to form soil-types having characteristic morphological and physicochemical features. Such "mature" soils, being the product of climate and vegetation, are termed *Zonal**. They include such great soil groups as *Desert Soils, Black Earths, Podzols* and *Lateritic Soils*, each of which develops under a distinctive climate. When the time factor is limited, true soils may not form, or their depth may be shallow. Such immature soils are called *Azonal*. In many instances, the predominance of some particular factor, as low relief (favoring permanent water-logging), or high content of salts or of lime in the parent rock, may preclude the full development of zonal soil groups, and other "deflected" groups of soils, called *Intrazonal*, may arise instead; these comprise *Hydromorphic, Halomorphic* and *Calomorphic* soils.

*Application to South America:* — (a) *Climate.* — The temperature and the rainfall maps (p. 156-160) show two distinct climatic patterns, one lying north of the 17th parallel, the other lying south of it. Within the first area, lines of equal rainfall are parabolic on the equator and run more or less parallel with lines of equal temperature, the climate becoming both wetter and hotter as the equator is approached from either side. Thus we would expect to find the humid tropical zonal soil groups (the so-called *Lateritic Soils*) here well developed, that is, over the greater part of Brazil, the Guianas and Venezuela, and the eastern parts of Colombia, Ecuador, Peru and northern Bolivia. Within the second area, lines of equal rainfall run *across* the lines of equal temperature roughly at right angles, the rainfall diminishing westwards to the base of the Andes. Thus we would expect to find the dry sub-tropical and temperate zonal soil groups (*Black Earth, Chestnut Earth, Desert*) developed as isolated patches in Uruguay, Paraguay, southern Bolivia, northern Argentina and northern Chile. Comparison with the soil map (p. 323) indicates that these coincidences actually occur, so that many of the chief Zonal World Soil Groups, originally recognised in Russia, have their near counterparts in South America.

Three special cases of South American zonal soils which seem to have no true analogues elsewhere deserve mention. The first occurs in the Chaco region in Argentina north of latitude 30°S. Here the climate is hot and moist in summer but very dry and cool in winter. The soil-type is called by MATTHEI (15) "*Light Brown Soil*", but the features seem more to resemble those described by THORP and BALDWIN for *Red Podzolic Soil* (22). MATTHEI's term, however, has here been retained. The second case occurs in the vast plateau region of southern Argentina (Patagonia) where low rainfall accompanies moderately low temperature. These conditions are associated with a desert type of soil which is regarded by MATTHEI as Azonal and designated by him "*Grey Skeletal Soil*". It is placed here in the *Gray Desert* zonal category, for the reason that time seems not to have been the limiting factor in its formation. The third case occurs in the southern Chilean Andes where the rainfall is high but the temperature moderately low, and the vegetation is coniferous forest. This soil-type is usually regarded as "podzolic", and it has accordingly been named provisionally *Gray-Brown Podzolic Soil;* MATTHEI designates it "*Grey Forest Soil*".

(b) *Vegetation.* — The maps on pp. 12-13 show the distribution of the main types of vegetation which follow closely the variations in climate. Detailed accounts of the vegetation of the various South American countries are being published in this volume.

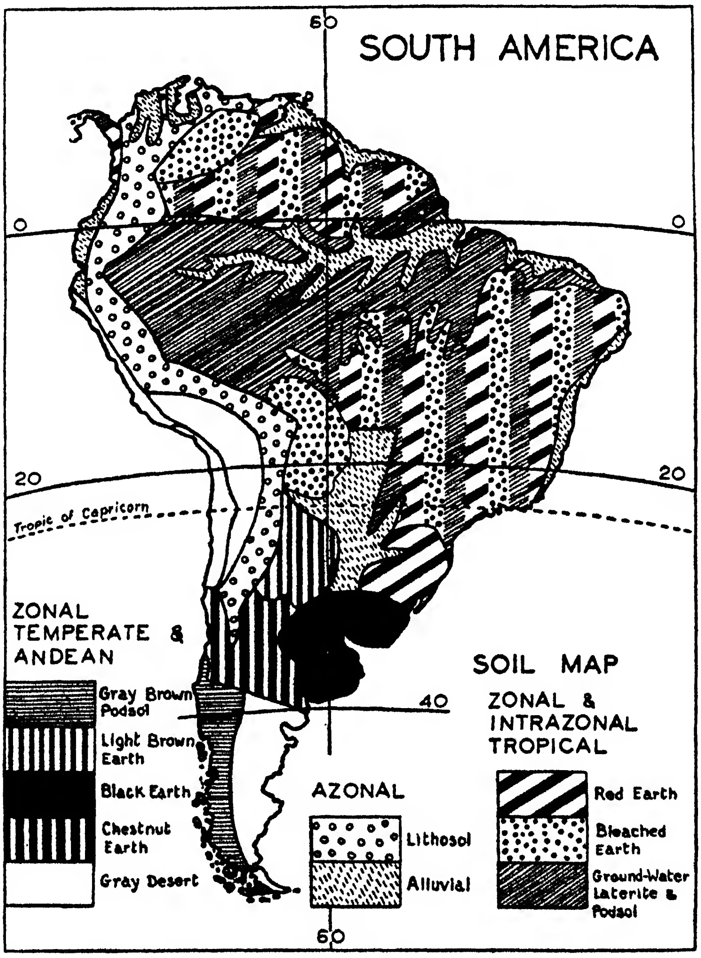
*Tropical Rain Forest* occupies most of the Amazon valley, and belts of it extend along the north-east and north-west coasts and along the eastern slopes of the northern Andes; in these areas rainfall is high and nearly continuous. It comprises a rich flora, including abundant epiphytes, lianes and palms, with *Hevea* rubber. *Montane Tropical Forest* covers the tops of the high mountains of the Guianas and eastern Brazil; it also is a luxuriant wet type of forest. *Caatinga Xerophilous Forest*, and *Xerophilous Woodland* (with *Quebracho*), are widespread at lower altitudes in eastern Brazil and the Chaco region; they consist chiefly of thorny *Mimosae* and *Cacti*. The rainfall is moderate and falls mostly in summer. The remaining forest vegetation is mainly *Coniferous Forest* which occupies the rainy southern Andes.

The greater part of South America is covered by a grassy vegetation, the most widespread of which is *Tropical Grassland* occupying the savannas of the Guianas, the campos of Brazil and the llanos of Venezuela and Bolivia. Here the dry season is

*Throughout this article the system of classification and nomenclature elaborated in the U.S.D.A. Yearbook for 1938 (*Soils and Men*) is employed.

long and severe, though the rest of the year is wet and floods are frequent. During droughts, the herbage is generally burnt up by fire. The vegetation of the Guianan savannas and the Venezuelan llanos is mainly of the "bunch-grass" type with sedges and prostrate leguminous herbs interspersed, together with scrubs (*Curatella, Byrsonima*) and palms (*Mauritia*) scattered sporadically (16, 17). Islands of tall trees or palm-stands occur in the moister places, and low forest fringes the river banks. The campos of the Matto Grosso, and very dry, (ii) the Andean Punta, altitude 14,000 feet, having moderate temperature, (iii) the Peruvian Coastal Belt, extending into the valleys and up the flanks of the Andes to 9000 feet, much of which is irrigable, and (iv) the Chilean Coastal Plateau, which is nearly rainless and contains extensive nitrate deposits.

(c) *Parent rocks and their weathering products.* — DARRAH's geological map of South America (this volume, p. 319) shows the distribution of the chief geological formations in South America. The




THE SOILS OF SOUTH AMERICA (*Original*).

elevation 1500 to 2500 feet, resemble the "orchard-bush" type. In the humid subtropics, in Uruguay and eastern Argentina, occurs the *Grassland Pampa*, which merges westwards and southwards under diminishing rainfall into the *Thorn Scrub Steppe* of northern Argentina and Patagonia. The vegetation of the northern Andes plateau is also of the *Steppe* type.

Finally, the *Deserts* of South America occupy four main areas, namely: (i) eastern Patagonia, which is cool, though windy greater part of the continent is lowland (two-thirds of it lies below 1000 feet), and is covered by Cenozoic sediments laid down in shallow arms of the sea or within the basins of the great river systems. These sediments merge in the south with other deposits forming the Patagonian plateau (elevation rising to 2000 feet). They have been much re-worked, and consist chiefly of quartzose, kaolinic and ferruginous residual materials generally devoid of fresh mutable minerals, though some contain calcareous

fossil remains and comprise marls and soft limestones. Volcanic, glacial and aeolian débris (loess) covers the sedimentary strata in many areas, notably the Argentine pampas.

The eastern and northern highlands of Brazil and the Guianas with Venezuela, separated by the Amazon valley, consist of the remnants of an ancient mountain system formed out of highly metamorphosed sediments, plutonic rocks, lava-flows and igneous intrusions, partly covered over by horizontally-bedded sandstones of different ages. The topography presents a series of scarped table-lands; the only true mountain ranges in this region (2000 to 4000 feet) occur near the east coast. Extensive lava sheets form most of the land surface in S.E. Brazil.

The great Western Cordillera, forming the third main geographical region of South America, rises to over 18,000 feet; the trend of its main ridges, longitudinal valleys and high plateaux is shown in the diagram. Its geological composition varies greatly. In the far south the rocks are mainly Archaean gneisses and granite. Further north, the western range consists of Mesozoic sediments lying on an early Palaeozoic basement, interspersed with volcanic eruptives, and the eastern range of Archaean and Palaeozoic sediments. The valleys and plateaux are filled in or covered over by colluvial and alluvial deposits derived from these ancient rocks, for example, the extensive gravelly accumulations of the Puna in western Bolivia.

The degree of decomposition and elutriation of the wide range of rocks represented in South America varies greatly, depending on climate and length of time of exposure. In the humid tropical region, for example, British Guiana, igneous and metamorphic rocks have given rise to "residual earths" whose mineralogical composition differs greatly according to the basicity of the original crystalline rocks (11, 12). Thus, basic rocks (hornblendic schists, diorite, dolerite, etc.) have given rise to *Red Earth*, consisting chiefly of kaolinite deeply stained with hydrous iron oxides or haematite and containing concretions of iron oxide and pieces of aluminous laterite, but acid rocks (granitic gneisses, granite, etc.) have given rise to thick masses of quartz-sand and white kaolinic clay, which may tentatively be called *Bleached Earth* (9). From these two extreme kinds of parent soil material, highly contrasted soil-types have developed, with many intermediate stages difficult to classify (5, 6). The first comprises neutral to slightly acid, crumb-structured, fertile red loams and clays; the second comprises highly acid, loose, grey or pale brown infertile sands and silts. These soils support distinctive kinds of Tropical Rain Forest (4). They may be regarded as mature Zonal soils; the first would be classed under *Lateritic Soils;* the second presumably under *Podzolic Soils,* though its bleached appearance and its high content of quartz are due to the *nature of the parent rock,* rather than to the operation of any specific soil-forming process (19). It mainly occurs on hill-crests, and on upland savanna plateaux.

Where residual granitic sand and clay have been redeposited as sediments (such as comprise certain Palaeozoic and Mesozoic strata occurring in the Guianan and Brazilian highlands), or where vast masses of Quaternary deposits (such as occur in Venezuela and Bolivia) have accumulated, they also have given rise to *Bleached Earth* over which similar grey "podzolic" soils have developed. Because of their inherently low fertility, the Bleached Earth Soils are only able to support a poor sort of forest vegetation where the climate is sufficiently wet (for example, Wallaba or Greenheart forests in British Guiana), but, where severe dry seasons intervene (as in the savannas, campos, and llanos), the original sparse forest vegetation is liable to destruction by fire, incident on the advent of man (16). The savanna forest is thus ultimately replaced by a grassland or scrub type of vegetation, the deflection being presumably favoured by the mobilisation through plant growth of the scant nutrient reserves of the parent soil materials and their rapid loss through leaching by rain water. The grassland vegetation of the savannas, campos and llanos may therefore be regarded as an "edaphic fire-climax" (18). Chemical analysis has indeed demonstrated the extremely low nutrient status of these savanna soils and of their natural herbage, as exemplified by the Rupununi and other savannas examined in British Guiana by FOLLETT-SMITH (7, 8). A counterpart of these savanna soils seems to occur in the orchard-bush savannas of Trinidad (10).

No attempt has been made in the soil map (p. 323) to delineate the occurrences of *Red Earth Soils* among the wide expanses of *Bleached Earth Soils* that occupy so much of the upland gneiss and sandstone savanna country of South America; the two have been mapped together (along with two other (Intrazonal) soil-types) as a geological *catena.* Exceptions have been recognised, however, in the cases of the large area of Red Earth occurring in south-eastern Brazil, and of the two extensive regions of Bleached Earth comprising the llanos of Venezuela and Bolivia. Neither has an attempt been made to differentiate the various subdivisions of Red Earth Soil which have been recognised by South American investigators (1), or conjectured by U. S. Bureau of Soils authorities (22).

(d) *Topography.* — In many parts of South America, low surface relief has proved to be more important than either climate or parent rock as chief agent of soil formation. For example, the depressed topography of the great basins of the Amazon, Orinoco, Paraguay, Parana and Uruguay Rivers has seriously impeded underground drainage, and has favoured the development of *Hydromorphic* and *Halomorphic* (Intrazonal) soil-types. The latter occur mainly over the vast arid river flats

of the south-centre of the continent and in the upland Puna where salt lakes surrounded by saline and alkali soils abound. The former occur mainly in the valley of the Amazon. Here MARBUT first recognised the prevailing soil as a true hydromorphic type (14). He noted the typical occurrence within the "zone of intermittent saturation" of an indurated slaggy layer of iron oxide which merges below into red-mottled clay lying over grey clay and passing into the original parent sedimentary rock at the base. Because of the similarity between this indurated layer and BUCHANAN's Indian laterite, MARBUT proposed to call the soil-type *"Ground Water Laterite"*. It is presumed to occupy a large part of the Amazon basin, with the chief exception of narrow riverain strips (varzea) consisting of recent alluvium (21). In addition (according to MARBUT), it covers large areas of elevated flat land in Central Brazil, though it here may be essentially a "fossil" soil. Another Hydromorphic soil which may be widespread in the Amazon basin and in the swampier parts of the lowland savannas and llanos of the Guianas and Venezuela, as well as in the forested peneplains, is *Ground-Water Podzol*. This may be difficult to distinguish from *Podzolic Bleached Earth Soil* when the total quantity of iron in the parent soil material is so small that ferruginous accumulations cannot form in the B-horizon (19). An important difference between Ground-Water Laterite and Ground-Water Podzol seems to lie in their different ages, for, whereas typical examples of Ground-Water Laterite appear to require 5 to 10 million years to develop (most are apparently of Pliocene age (22) ), the Podzol may be much younger, especially when profile differentiation is rapidly attained because of a low iron content.

The Amazonian soils are shown in the map as Intrazonal, except for the strips of recent *Alluvial Soil* bordering the lower river courses. (MATTHEI's map (15) depicts alluvium occupying the whole of the Amazon basin). The plateau Ground-Water Laterite is mapped as part of the catena above-mentioned.

Other Hydromorphic Intrazonal soils recognised by the U. S. Bureau of Soils are *Meadow Soils, Bog Soils, Half Bog Soils* and *Planosols*. These are doubtless represented in the swampy lands of South America, but they will not here be further considered. Nor will the remaining Intrazonal soils, namely, the *Calomorphic* types - *Rendzina* and *Brown Forest Soil* developed over calcareous rocks - be more than mentioned, though they are widespread among the sedimentary rock soils of the pampas and the coastal hills of South Brazil.

| | Climate | Vegetation | Usage |
|---|---|---|---|
| *ZONAL SOILS:-* | | | |
| Desert | Arid; hot, cool | Scrubby | Grazing |
| Chestnut Earth | Semi-arid | Grass | Grazing |
| Black Earth | Sub-humid | Grass | Cereals |
| Bleached Earth (Podzol) | Humid | Grass; forest | Grazing |
| Gray-Brown Podzol | Humid | Forest | Timber |
| Red Earth (Lateritic) | (Sub-tropical to Tropical) | | |
| Yellow Podzolic | Humid | Deciduous forest | Mixed crops |
| Red Podzolic (Light Brown) | Humid | Deciduous forest | Mixed crops |
| Yellowish-Brown | Wet-dry | Rain forest | Crops; timber |
| Reddish-Brown | Wet-dry | Rain forest | Plantation crops |
| Laterite | Wet-dry | Rain forest | ? |
| *INTRAZONAL SOILS:-* | | | |
| *HALOMORPHIC:-* | | | |
| Solonchak (Saline) / Solonetz (Alkali) | Sub-humid | Halophytes | Grazing or waste |
| *HYDROMORPHIC:-* | | | |
| Meadow | Humid, cool | Grass; sedge | Grazing |
| Alpine Meadow | Cool; frigid | Grass; sedge | Grazing |
| Bog / Half Bog | Cool; tropical, humid | Forest; grass | Grazing |
| Planosol | Sub-humid | Forest; grass | Grazing |
| Ground-Water Podzol / Ground-Water Laterite | Humid | Forest | ? |
| *CALOMORPHIC:-* | | | |
| Brown Forest | Humid | Forest | Mixed crops |
| Rendzina | Sub-humid | Grass | Mixed crops |
| *AZONAL SOILS:-* | | | |
| Lithosols / Alluvial Soils / Dry Sands | All climates | Depends on climate | Various |

Table summarizing the chief soil types which appear to occur in South America, and their broad climatic and vegetation relationships and agricultural usage. The scheme of classification follows that elaborated by the United States Bureau of Soils.

Finally, among the Azonal soils, skeletal *Lithosols* abound on the mountain slopes and over the plateaux, and in the transverse and longitudinal valleys of the high Western Cordillera, and *Alluvial Soils* and *Dry Sand Soils* occupy large areas of riverain and coastal country in all parts of the continent. Their chief occurrences are shown in the soil map.

*Agricultural usage:* The agricultural development of South America, chiefly confined to the eastern temperate plains and the subtropical Andean plateaux, is passing through a transition stage. Two-thirds of the total exports at present come from the south-eastern part of the continent where nearly three-quarters of the population resides (23). The most productive soil-type is *Black Earth* occurring in Argentina and Uruguay on which are located (i) the Wheat Crescent (growing mostly cereals), (ii) the Corn-Flax region, (iii) the Eastern Pampas and part of the Paraná-Uruguay Grazing regions,

and (iv) the La Plata Dairying region, described by JONES (13). Westward, the soil changes into *Chestnut Earth*, a more arid type merging in the south with the Patagonian plateau *Desert* soil, which together comprise the vast region of Differential Grazing (3). Northwards in the Chaco, as the Chestnut Earth changes with increasing temperature into *Light Brown Earth*, subtropical conditions prevail, and the grazing diminishes in value. The natural vegetation here includes *Quebracho* which is exploited commercially. In eastern Chaco, a cotton-growing industry has recently developed. Further east, where the Brazilian Highlands begin and the climate is wetter, lies the Subtropical Pine and Yerba Maté Forest, occupying transitional *Red Earth Soil*.

The other regions of diversified temperate and subtropical agriculture in South America are confined to the Andean plateaux and to parts of the Pacific coastal plains and valleys, whose soils are very varied, chiefly comprising *Lithosols* and *Alluvial* types. Thus, within the temperate parts of Chile, Peru, Ecuador, Colombia and Venezuela, some nine different agricultural regions have been identified and described by JONES (13). Certain of these comprise good grazing grounds as well as land suited to the production of a wide range of crops.

The *tropical agricultural regions* of South America are mostly confined to south-east Brazil where nearly two-thirds of the country's cultivated soils occur. The chief tropical crop is coffee, which is extensively grown on *Red Earth Soil*, being particularly successful on soils derived from basic igneous rock (13). Cacao is grown further north in Bahia on the coastal plain *Alluvial Soil* and on the older soils of the lower slopes of the highlands (2). Cotton and sugar-cane are mainly produced still further north, near the "shoulder" of Brazil, on *Alluvial* and *Red Earth Soils* of the coastal plain and the inland plateau respectively. Further inland, within the semi-arid highlands of north-east Brazil, the chief agricultural industry is cattle grazing. Still further westwards, occurs the vast Campos Grazing Region extending to Bolivia and Paraguay, which has its counterpart north of the Amazon basin in the grazing regions of the Venezuelan llanos and the Guianan savannas. The most important agricultural region in the north is the Guianan Littoral, comprising marine, estuarine and riverain *Alluvial Soils* chiefly used for sugar-cane growing. The forested Amazon basin is a Region of Primitive Agriculture, as yet little developed, though it yields rubber and cacao.

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE,
TRINIDAD, BRITISH WEST INDIES.

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C. W. EMMONS: **Medical Mycology in Latin America**:- Interest in Medical Mycology arose early in South America and a consistent flow of valuable contributions to our knowledge of the fungi which cause disease in man continues from the large medical centers of that continent. Of recent years an increasing number of reports of mycoses, and of discussions of pathogenic fungi have appeared from the smaller Latin American countries. These contributions, brief as many of them are, are more significant than might at first appear, because of certain peculiarities of the mycotic diseases. The mycoses differ epidemiologically as well as in other important fundamental respects from most bacterial diseases. They are preëminently sporadic in appearance. Generally speaking they are not contagious, and with the exception of the dermatophytes, transmission from one individual to another is rare indeed. Even in the case of the more virulent pathogenic fungi, it appears that the etiologic agent either may be carried normally as a harmless saprophyte on the body surfaces, or invades the host from an exogenous source. In either case parasitism of man seems to be accidental, and the conditions under which the attack occurs are not properly understood. For these and other reasons, the publication of case reports of mycoses,

particularly from new geographical areas often adds valuable information about the distinctive features or geographical limits of a mycosis. In those cases where the fungus has its normal habitat in man's external environment the presence or absence of a given mycosis depends upon whether the fungus is present in that area. Some of these fungi which have an exogenous source and appear to invade human hosts by accident are restricted to certain areas by climate or other influences so that the diseases they cause have an endemic distribution. Others are widely distributed, and the corresponding diseases, while sporadic in appearance, are world wide in distribution. The geographical limits of even the more common and important mycoses are still poorly known, due in part to our failure to look for or recognize them. The Latin American countries have made important contributions to our knowledge of those mycoses known from restricted endemic areas, as well as of those which are widely distributed over the earth.

As early as 1892 POSADAS, assistant to Dr. WERNICKE, Professor of Pathology in the School of Medicine at Buenos Aires, studying a granulomatous disease in the Chaco region of northern Argentina, found the etiologic agent which he believed to be a protozoan. This organism was later found in similar cases in California and named *Coccidioides immitis*. The two important endemic areas of the disease caused by this fungus are the two where it was first studied, viz., northern Argentina and areas in the arid southwest of the United States.

SEEBER, also a student of WERNICKE, was the first to study rhinosporidiosis and the etiologic agent was named in his honor *Rhinosporidium seeberi*. The history of Argentine medicine was further enriched by the studies of LIGNIÈRES and SPITZ, who, for the first time, clearly differentiated between actinomycosis and actinobacillosis. MAROTTA introduced vaccine therapy into the treatment of actinomycosis.

The example set by these early Argentine investigators has been ably carried forward by NEGRONI, NIÑO, and their associates. NEGRONI has published numerous papers on actinomycosis, its frequency, clinical variations, and its treatment by vaccines; on moniliasis of various types; the use of antigens prepared from *Candida* (*Monilia*); the antigenic properties of the capsular substance in *Candida;* chromoblastomycosis; coccidioidomycosis; paracoccidioidal granuloma; dermatophytosis; histoplasmosis; and on the mycology of the various pathogenic fungi.

Brasil's contributions to Medical Mycology, although not going back to so early a date as those of Argentina, are equally important. The list of Brasilian medical mycologists is a long and illustrious one. Here, as in the early studies mentioned above, the principal problems involved were recognition of the etiologies and differentiation from other similar diseases. LUTZ, CARINI, and SPLENDORE from 1905 to 1912 studied and described as a new disease, paracoccidioidal granuloma which has been frequently confused with coccidioidal granuloma. It is an important disease in Brasil, and is seen elsewhere in South America. ALMEIDA has clearly pointed out the distinguishing features of this disease. PEDROSO studied in 1911 for the first time, and described in 1920 a condition now known as chromoblastomycosis. BRUMPT in 1922 named the fungus *Hormodendrum pedrosoi* in honor of PEDROSO who first isolated it. HORTA in 1911 carefully described piedra, and the fungus causing it in Brasil has been named in his honor.

More recent Brasilian contributions have been numerous and have extended the known range of certain mycoses or have added to our knowledge of their peculiarities. FONSECA and ARÊA LEÃO separately or jointly have published many papers on coccidioidomycosis, paracoccidioidal granuloma, chromoblastomycosis, dermatophytosis, piedra, moniliasis, blastomycosis, and general discussions of pathogenic fungi. These investigators recommend vaccine therapy for dermatophytosis. ALMEIDA, besides his numerous contributions to the differentiation of coccidioidomycosis, and paracoccidioidal granuloma has published papers on chromoblastomycosis, actinomycosis, sporotrichosis, histoplasmosis and piedra, and general papers on mycoses of interest in Brasil. Other contributors to the mycopathological literature of Brasil, particularly that concerning the dermatophytes and sporotrichosis have been MAGALHÃES, PEREIRA FILHO, ROCHA LIMA, and MARTINS DE CASTRO.

In Uruguay, TALICE and MACKINNON reported blastomycosis. MACKINNON has published several important papers on variations in *Candida albicans* and serologic and morphologic studies of this fungus; actinomycosis; aspergillosis; and mushroom poisoning.

NICOLAU OZORIO and POSADA ARANGO in 1876 studied the pale colored variety of piedra in Columbia, and much later DELAMARE and GATTI reported their studies on the black form found in Paraguay.

In Venezuela, BRICEÑO IRAGORRY has reported the occurrence of chromoblastomycosis. IRIARTE published a number of observations on pinta, and in one of these summarized the evidence showing that this is not a fungous infection, as was formerly believed.

In Guatemala, MORALES reported a case of chromoblastomycosis, and this disease was also reported from Costa Rica by SALISBURY.

In Mexico the studies of GONZALES HERREJON and PALLARES proved that the earlier conception of a mycotic etiology in mal del pinto was false and that this disease is actually a treponematosis. This was confirmed by LEON Y BLANCO, a Cuban working in Mexico, whose studies of the etiology, epidemiology and experimental transmission of pinta are monumental, and by numerous other Latin American investigators. Recently GONZALES OCHOA has carried on extensive and valuable studies

of dermatophytosis, actinomycosis, chromoblastomycosis and sporotrichosis in Mexico.

PARDO CASTELLO and HOFFMAN have discussed the mycopathological problems of Cuba, particularly those of dermatophytosis and chromoblastomycosis.

In Puerto Rico early publications by ASHFORD discussed the common association of *Candida albicans* (*Monilia psilosis*) with tropical sprue. He published a number of papers on the general subject of medical mycology, particularly as it related to tropical medicine. Important contributions have more recently been made by CARRIÓN, who has studied carefully and reported dermatophytosis, chromoblastomycosis, actinomycosis, and cephalosporiosis, as they occur on this semitropical United States island.

This short list of contributions made by the medical mycologists of Latin America is by no means complete. Those named have had a wider interest in the subject than is indicated by the references given to some of their published reports. Other men besides those named have made important contributions. The partial list given does indicate the lines along which medical mycology has developed in Latin America. It is natural that the greatest significance of the early contributions was that they brought to attention new or poorly known mycoses. This phase of development in medical mycology is not yet completed either for Latin America or for other parts of the world for reasons already enumerated. Consideration of the fact that coccidioidal granuloma, rhinosporidiosis, chromoblastomycosis, and paracoccidioidal granuloma were first studied and reported in South America clearly indicates the importance of the contributions made by those nations. It is altogether probable that additional new mycoses will from time to time be reported from Latin America and that the known geographical limits of other mycoses will be extended. Many parts of tropical America are still virgin territory insofar as accurate knowledge of the incidence of mycoses is concerned. Because of the greater prevalence of fungi in tropical countries, it is almost certain that new or rare pathogenic fungi remain to be discovered in these areas.

Besides the type of pioneer investigations just mentioned which involve careful proof of the etiology of new or poorly known mycoses and their precise differentiation from similar diseases, we may expect further studies from the serological, genetical, and therapeutic approaches, following those already published from the great medical centers of South America.

Coöperation between medical mycologists of Latin and North America is certain to result in benefit to both. Problems of medical mycology can best be studied from a background of broad general knowledge of the subject. The insular point of view handicaps the study of a disease which may be world wide in distribution or may differ slightly from its counterpart in another part of the world. The free interchange of ideas, reprints, cultures, and other materials will aid in studies made on both sides of the equator and will contribute toward the integration of a difficult subject.

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HAROLD J. COOLIDGE, Jr.*: Notes on Conservation in The Americas:- Any approach to the problem of the Conservation of Nature in The Americas should take into account the physical aspects of the countries, the fauna and flora, and the population with its general distribution and its probable distribution and land uses in the years to come. South America is the fourth in magnitude among the great land masses of the world, with an area of some 6,800,000 square miles. On the western edge of this continent looms the great Andean Mountain chain averaging 13,000 feet in height and extending like a great serpent for 4,400 miles. These mountains act as a giant condenser in the Trade wind belt forcing on their eastern slopes the precipitation of moisture which, in turn, forms the largest river system in the world. The Amazon and its tributaries flow for the most part through dense vegetation teeming with animal life. The Amazon, Orinoco, and La Plata rivers together drain 3,500,000 square miles.

Between the Atlantic and the Andes, the Brazilian state of Matto Grosso and the Caribbean lies the most extensive virgin forest in the world. Much of this is still unexplored for several reasons. The undergrowth is so dense that one can only get through by cutting one's way with a machete, requiring great exertion; certain of the remote areas are still inhabited by hostile warlike Indians; and thousands of miles of this great area are completely flooded during the rainy season.

This great forest is a paradise for indigenous animals and plants, although large mammals are conspicuously absent. The Amazon forest offers a gold mine for

*Chairman of the Pan-American Committee of the American Committee for International Wildlife Protection.

the naturalist, and as CUTRIGHT† points out, in eleven years BATES collected 14,000 species of insects, 360 of birds, 140 of reptiles, 120 of fishes, and 52 of mammals. These figures give some idea of life abundance in the Amazonian tropical forest.

There are other great regions of South America besides the tropical forest that challenge the naturalist. We have the broad plains of Paraguay, Uruguay, and Southern Brazil, the pampas of the Argentine, the barren lands of Patagonia, and the altitude zones of the western slopes of the Andes, varying from the teeming bird life of the barren Guano Islands washed by the Peru Current to the lofty pinnacled home of the Andean Condor, or the high plateaus where many wild vicuñas and perhaps a few chinchillas still survive. Each of these regions has its own characteristic flora and fauna of special interest to the naturalist. South America is biologically the least well-known continent. This is in part due to the difficulty of travel there, because of the great size of its mountains and rivers, the scarcity of native population, and the vast distances to be traversed through unhealthy swampy jungles.

authorizing the withdrawal of areas of the Public Domain as forest reserves.

In May, 1940, the collective experience of the United States, the Argentine, Mexico, and most of the other American Republics, in dealing with conservation problems, was brought to bear on the problem of a hemispheric approach to establishing a workable pattern for the future preservation of wild life in the Americas through international agreement, under the auspices of the Pan American Union. A study was made of the possible application of provisions of the existing Migratory Bird Treaties between the United States and Canada and Mexico (1916 and 1936) as well as the provisions of the only existing International Convention of a remotely similar nature (The London-African Convention of 1933).

A committee of experts from the Argentine, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Haiti, Mexico, Panama, Paraguay, Peru, United States, Uruguay, and Venezuela produced the Pan American Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere. This treaty has since been signed by all

*STATISTICS**

| *Country* | *Area in square miles* | *Population* | *Density of Population per sq. m.* | *Railway Mileage* | *Road Mileage* |
|---|---|---|---|---|---|
| Argentina | 1,079,965 | 13,318,320 | 12.3 | 25,685 | 254,646 |
| Bolivia | 416,040 | 3,457,000 | 8.3 | 1,399 | 5,788 |
| Brazil | 3,286,170 | 45,002,176 | 13.7 | 21,250 | 119,688 |
| Chile | 286,396 | 5,016,449 | 17.5 | 5,600 | 22,613 |
| Colombia | 439,828 | 8,701,816 | 19.8 | 1,400 | 14,637 |
| Costa Rica | 23,000 | 639,197 | 27.8 | 450 | 820 |
| Cuba | 44,164 | 4,227,597 | 95.7 | 3,000 | 2,269 |
| Dominican Republic | 19,325 | 1,655,779 | 85.7 | 150 | 3,925 |
| Ecuador | 175,855(a) | 2,921,688 | | 600 | 2,999 |
| El Salvador | 13,176 | 1,744,535 | 132.4 | 375 | 3,648 |
| Guatemala | 45,452 | 3,284,269 | 72.3 | 510 | 3,567 |
| Haiti | 10,700 | 2,652,000 | 247.9 | 162 | 1,418 |
| Honduras | 46,332 | 1,109,883 | 24.0 | 878 | 511 |
| Mexico | 758,258 | 19,546,135 | 25.8 | 14,500 | 56,923 |
| Nicaragua | 57,143 | 1,380,287 | 24.1 | 227 | 1,670 |
| Panama | 32,827 | 578,351 | 17.5 | 257 | 1,011(b) |
| Paraguay | 170,000(c) | 1,014,773 | 6.0 | 713 | 4,009 |
| Peru | 482,133(d) | 6,762,881 | 14.0 | 2,624 | 14,074 |
| Uruguay | 72,153 | 2,146,545 | 29.7 | 1,800 | 22,487 |
| Venezuela | 352,170 | 3,491,159 | 9.9 | 563 | 5,881 |

Among the early great naturalists that made known to science the wonders of this continent are such names as HUMBOLDT, WATERTON, SCHOMBURGK, WALLACE, BATES, SPRUCE, DARWIN, and HUDSON.

For the purposes of this discussion we are not including North America, with the exception of Mexico, because there is a vast conservation literature dealing with this subject. No one will dispute the fact that the United States has taken the lead in the New World when it comes to the enacting of game laws, the setting aside of Wildlife and Forest Reserves, the establishment of National Parks. Lest we pat ourselves too much on the back, let us remember the fate of the passenger pigeon, the Carolina paroquet, the California grizzly, and the heath hen. It was only in 1872 that the idea of national ownership of great natural spectacles was born beside a campfire in the Yellowstone. It wasn't until 1891 that Congress passed an act

†P. R. CUTRIGHT, 1940: *The Great Naturalists Explore South America* (Macmillan, 340 pp.).

the American Republics except Panama, Paraguay, and Honduras, and has already been ratified by Mexico, the United States, Guatemala, Venezuela, El Salvador, Haiti, the Dominican Republic, and Peru. More than five ratifications having been deposited with the Pan American Union brings the treaty into effect on May 1st, 1942.

"It establishes a basic pattern for a scheme of parks and reserves throughout the Americas which our own experience has taught us is thoroughly sound. It provides for appropriate protective laws for flora and fauna where inadequate ones exist. It favors coöperation in scientific field studies, the protection of migratory birds, the protection of vanishing species listed in a special annex, and the control of contraband fauna or flora protected by the laws of another country.

*Compiled by the Pan-American Union. Official sources used where possible.
(a) South American Handbook, 1940.
(b) Includes Canal Zone.
(c) Tentative.
(d) Statesman's Yearbook, 1940.

The following are the definitions of four categories of parks and reserves under the terms of the convention:

1. The expression "National Parks" shall denote: Areas established for the protection and preservation of superlative scenery, flora and fauna of national significance which the general public may enjoy and from which it may benefit when placed under public control.

2. The expression "National Reserves" shall denote: Regions established for conservation and utilization of natural resources under government control, on which protection of animal and plant life will be afforded in so far as this may be consistent with the primary purposes of such reserves.

*Pan American National Parks* (except Mexico and United States):- 1, Nahuel Huapi, Argentina (784,682 ha.); 2(*a*), Iguasu, Argentina and (*b*) Iguasu, Brasil (315,000 ha.); 3, Lanin, Argentina (559,773 ha.); 4. Los Alceres, Argentina (499,798 ha.); 5, Perito Francisco P. Moreno, Argentina (154,937 ha.); 6, Los Glaciares, Argentina (669,729 ha.); 7, Itatyaia, Brazil (11,043 ha.); 8, Serra dos Organos, Brazil; 9, Easter Island, Chile; 10, Juan Fernandez Islands, Chile; 11, Vicente Pérez Rosales, Chile (135,175 ha.); 12, El Cristal, Cuba (26,305 ha.); 13, Cienaga de Zapata, Cuba, (Sanctuary) (179,449 ha.); 14, Las Matas, Dominican Republic (19,992 ha.); 15, Certain Islands of the Galapagos, Ecuador (405 sq. mi.); 16, Kaietur, British Guiana (45 sq. mi.); 17, Mexico, 36 Parks (514,237 ha.); 18, In Aragua State, Venezuela (250,000 ha.); 19, National Park of Carrasco, Uruguay (334 ha.).

3. The expression "Nature Monuments" shall denote: Regions, objects or living species of flora or fauna of esthetic, historic or scientific interest to which strict protection is given. The purpose of nature monuments is the protection of a specific object, or a species of flora and fauna, by setting aside an area, an object or a single species, as an inviolate nature monument, except for duly authorized scientific investigations or government inspection.

4. The expression "Strict Wilderness Reserves" shall denote: A region under public control characterized by primitive conditions of flora, fauna, transportation and habitation wherein there is no provision for the passage of motorized transportation and all commercial developments are excluded."

There follow several articles dealing with the establishment of these parks and reserves.

NEWTON B. DRURY, Director of the United States National Park Service, says of it, "I see in this Convention the spark that may arouse to crusading vigor the preservation of superlative examples of nature throughout the Americas. May it be another Yellowstone campfire from which inspired men will go forth to fight destruction of the unique natural assets of the entire New World".

The "Committee of Experts", in framing this Convention, were very conscious of the important part that parks and reserves will serve for ecological studies of plant and animal life in the years to come. In several places in the Convention where necessary restrictions are imposed, one finds the phrase "except for duly authorized scientific investigations". In addition, there is a scientific safeguard in Article VI which says:

"The Contracting Governments agree to cooperate among themselves in promoting the objectives of the present Convention. To this end they will lend proper assistance, consistent with national laws, to scientists of the American Republics engaged in research and field study; they may, when circumstances warrant, enter into agreements with one another or with scientific institutions of the Americas in order to increase the effectiveness of this collaboration; and they shall make available to all the American Republics equally through publication or otherwise the scientific knowledge resulting from such cooperative effort."

In order to make this convention effective it must first be ratified by the American Republics who have not already done so. Then appropriate enabling legislation must be passed in order to establish it more effectively as the law of the land in the various countries that favor its provisions. A suggestion has been made that a small group of international technical advisors be set up. Such a group would probably consist of a zoologist, a botanist, and an experienced National Park man. These advisors should speak Spanish and be the kind of men who would be "simpático" with associates and officials of the American Republics. They should each in his special field have a wide knowledge of the fauna and flora of national parks of the New World. These advisors could be invited by the government of any of the American Republics to make a study of problems in connection with carrying out provisions of the convention, and the results of their findings should prove of great assistance to the respective governments that make use of this service. It has been suggested that some International Foundation pay the salaries of these advisors but that their travelling, living, and field expenses might be paid by the governments making use of them.

If we should take a migratory birdseye view of conservation activities in the American Republics we should find eighteen National Parks (see map) excluding those in the United States and Mexico. We would also gather the general information

set forth in the following pages† which should be considered in the light of the vital statistics set forth in the table.

### *ARGENTINA*[1]

The Argentine, with its more than a million square miles of area and a population of over thirteen million, has a wide range of natural scenery, fauna, and flora. It has been the leader among the American Republics in the establishment of conservation measures, especially national parks.

In 1903, Dr. FRANCISCO P. MORENO donated to the Argentine nation the nucleus of what was to become the great Nahuel Huapi National Park. This magnificent park of close to two million acres with its snow peaks, lakes, and great cypress forests, is filled with virgin fauna and flora as well as unique natural scenery. The flora of the region includes the following typical species:

the coihué, *Nothofagus dombeyi*
the ciprés, *Libocedrus chilensis*
the lenga, *Nothofagus pumilio*
the ñire, *Nothofagus antarctica*
the arrayán, *Myrceugenia apiculata*
the cavenia, *Acacia cavenia*
the virreina, *Muticia retrorsa*
Darwin barberry, *Berberis darwinii*
the chilco, *Fuchsia macrosanta*

In the Patagonian Cordillera there are four national parks, established by decree of May 11, 1937. Also there was established the national reserve of "Los Copahues". The "Lanin" National Park is dominated by the inactive volcano of that name. The flora is characterized by great forests of araucaria, in some cases, mixed with coihué, roble, lenga, and raulí. "Los Alerces" National Park, with its large forests of alerces and woods of maitén, is in danger from forest fires. The woods also include laerce, lenga, and ñire.

"Perito Francisco P. Moreno" National Park has perpetual snow peaks and beautiful lakes, as well as a great tableland region. The forest resources are largely limited to the *lenga*, and the most important of the tableland pastures is the *coiron*.

"Los Glaciares" National Park is a region where guanacos and huemules still survive in the high mountains. The features of this park are the glaciers. The woody flora of the sub-glacial region is principally made up of "lenga", *Nothofagus pumilio*, as well as the "beech (roble)", *Nothofagus* antarctica, and the "coihué," *Nothofagus betuloides*. In addition, the following species are found in the park:

The winter's-bark tree, *Drimys winteri*
The ciruelillo, *Embothrium coccineum*
The barberry, *Berberis buxifolia* and *Berberis ilicifolia*
The pernettya, *Pernettya macrocoronata*
The Magellan fuchsia, *Fuchsia magellanica*
The hardwood, *Maytenus magellanica*

In the North there is the splendid "Iguazú" National Park with its luxuriant sub-tropical forest and the picturesque cataracts of the Paraná River. Adjoining is a Brazilian park.

As a result of information assembled through the Pan American Union it might be well to mention certain species of plants that are reported in process of extinction.

The Araucaria of Neuquén, or "pehuén", *Araucaria araucana*, together with other *Gymnospermae* of the sub-Antarctic forests, *Dacrydium fonckii*, *Saxegothaea conspicua*, etc., are species which are becoming progressively rarer in their natural habitat.

The palms of Concordia, *Cocos yatay*, of which only old specimens may be observed and none of small or intermediate size, are tending to disappear; this is perhaps due to grazing of the land by livestock, which, during the frequent shortages of pasture, feed eagerly upon the young palms.

The palm of Cordoba, *Trithrinax campestris*, in many places is on the way to disappearing, due to the use which is made of its leaves, and to the practice of burning over fields to be used in construction or placed under cultivation.

Other species which may be said to be on the road to extinction include the *Plantago bismarcki*, in the region of the Sierra de la Ventana; the curious and well-known anchor plant, *Colletia cruciata*, found between Balcarce and Mar del Plata; the red *quebracho*, or "quebracho colorado", *Schinopsis* balansae Engl., and the *umburana*, *Torresea cearensis*. The two last-named species may be too rapidly exploited in a country lacking a law that guarantees reforestation.

The Argentine has national and provincial hunting laws. The basic legal provisions for the protection of animal life in the territories under Federal jurisdiction were embodied in a 1924 Presidential decree which established a closed season on rare animals and birds, the protection of birds' eggs, nests, and birds useful to agriculture, the seasonal protection of certain game birds, but no provision for migratory birds. It is very much to be hoped that the same spirit and vision that has led to the creation of their splendid national parks, and the Bureau of National Parks (1934) for their administration, will also further other aspects of the International Convention within the Argentine.

### *BOLIVIA*

Bolivia has proportionately the least population per square mile in the Americas next to Paraguay, which is even less populous. Such rare animals as the chinchillas, vicuña, and guanacos are found there. As far back as 1868 there was a law prohibiting the export of alpaca skins, and in 1906 the hunting of chinchillas was first prohibited. A decree of 1922 prohibits the taking of eggs and the hunting of birds from October to April. A law has recently been passed forbidding the exportation of vicuña skins.

There are no parks or reserves established in Bolivia, although there are many suitable places including such famous archaeological sites as the early ruins at Tiatuanacu. More stringent enforcement of laws protecting the rarities of the Bolivian fauna would prove beneficial to their preservation. It is greatly to be hoped that Bolivia will adopt the pattern of the International Convention and set about establishing parks and reserves.

### *BRAZIL*

Brazil has a grave responsibility on account of its enormous area of over three million square miles to set aside large and numerous parks and reserves for future generations. A large area in the Itatyaia region was acquired about 1906 for a forest reserve and botanical station, and in 1937 the Itatyaia National Park was established. This park makes a beautiful primitive nature monument, readily accessible, with facilities for naturalists. Besides this there is the Iguazú National Park established in 1939, adjoining the famous falls and the Argentine park. There is also the Serra dos Organos National Park (1939), dominated by the rocky mountain "Dedo de Deus", plainly seen from Rio.

The Brazilian forest legislation is very broad. The code adopted in 1934 declares all forests taken as a whole to be of national interest, and establishes that property rights thereon shall be enjoyed subject to the limitations imposed by law. The Forest Code provisions apply to forests as well as all floral aggregations of recognized usefulness to the lands on which they stand. Forests are exempt from taxation in that their existence does not increase the tax value of the land on which they stand. Lands covered with what are classified as Protective Forests are exempt from all taxes. Such forests

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†The controversial subsection of fisheries has been excluded from the treaty, and from this discussion.

[1]This section is based largely on documentary material assembled by the Pan American Union and the Pan American Section of the American Committee for International Wildlife Protection. It also includes information which the author wishes to gratefully acknowledge from Dr. WALLACE W. ATWOOD's report on *The Protection of Nature in the Americas*, publication Number 50, of the Instituto Panamericano de Geografía e Historia, and from articles by T. GILBERT PEARSON, Chairman of the Pan-American Section of the International Committee for Bird Preservation.

shall be permanently preserved and must be maintained according to law. The law provides for a Federal forestry council and Municipal councils to help administer the Forest Fund and Code.

In Brazil the Federal government has sole jurisdiction over hunting in the entire territory of the nation. It may delegate powers of regulation to the states, but they can only legislate to supplement the Federal law according to instructions issued for this purpose.

Animals useful to agriculture, homing pigeons, song, ornamental, and small birds not harmful to agriculture, and certain rare species are all protected. A hunter must have a license to carry arms and a hunting license of the appropriate type. There are closed seasons, laws protecting eggs, nests, and rare species. A special license is required to hunt and trade in ornamental insects, especially butterflies. Scientific expeditions for collecting wild animals and hunting expeditions of tourists have to take with them a representative of the armed forces, an expert from the Bureau of Game & Fisheries, and scientists of national institutions at their own expense.

A national game board is set up to administer the Game Code and encourage hunting and shooting contests.

The comprehensive Brazilian laws and especially the National Game Board, as well as the Federal law power, should greatly facilitate Brazil's playing an important part in carrying out the provisions of the International Convention.

### *CHILE*

In 1935, the Chilean Government established Easter Island and the Juan Fernandez Islands as national parks. These are both meccas for scientific investigators in various fields. The mystery of the Easter Islanders' ability to read and write when other Polynesians couldn't has not been solved. In governmental decree 552, about 1928 there was established "a national park for tourists" known as Vicente Pérez Rosales, in the Province of Chiloe, with an area of 135,175 hectares. Since then there have been a number of forest reserves set up as tourist parks, Tolhuaca, Nahuelbuta, and Nielol, but the laws governing them do not conform to the national park conception as envisaged in the Convention; so the original Vicente Pérez Rosales of 327,000 acres and the islands are the only ones listed on the map.

Chile has protective game laws, especially regarding the chinchilla. Her fauna includes the guanaco and vicuña, which have been greatly reduced by commercial hunting. Fur farming is taking hold in Chile, and there is increasing realization of the value of protective game laws.

The broad gauge forest reserves such as Alto Bio-Bio, Malleco, Malacahuello, Villarrica, Valdivia, Llanquihue, and the Reserva Forestal de Tolten and de El Sauce may very well fit into one or more categories of the Convention. Chile has made the most important conservation start of any west coast country, and the topography of the western slope of the Andes would lend itself to numerous smaller parks and reserves that include forests and impressive natural scenery.

### *COLOMBIA**

In Colombia, forest reserves have only been created on national property under a law of 1919. These are subject to a strict control with regard to reforestation and the protection of birds and flowers.

Within the past year Colombia enacted a new and fairly comprehensive game law. Before that the only provisions were in the Civil Codes. Under a law of 1926 the Executive shall issue sanitary regulations concerning agriculture and the livestock industry. When these are issued they will contain provisions relative to wild game.

On March 7, 1941, the new decree was signed by President EDUARDO SANTOS. Its provisions include prohibiting hunting for a ten-year period of certain species of birds. Among these are the upland plovers, robins, woodpeckers, herons, thrushes, and sparrows. Ducks and geese are given a seven months' closed season from April 1 to November 1. Tinamous and shore birds are protected for nine months. The sale of protected wild birds is prohibited during the closed season. A gun license issued without cost is required by all hunters. Anteaters, palmeros, and silver martins are protected for five years. Female deer are protected at all times. Otters, colored monkeys, wolves, water-rats and some other mammals are protected until they attain a certain specified length. Local mayors and magistrates are empowered to enforce the decree, and scientific permits may be secured from the Section of Fishing and Hunting of the Ministry of National Economy.

It is clear that Colombia, with its increasing road mileage and expanding agriculture, is in a stage of development to greatly benefit by carrying out provisions of the International Convention. A reserve might be established, in part, of the beautiful Santa Marta Range.

### *COSTA RICA***

The territory within 2,000 metres of the Poas volcano, amounting to 1,250 hectares, was set aside as a national reserve by a decree of June 21, 1913. While there are no reserved areas for the protection of wild animals, nor for historical parks, there is a State controlled area of 60,000 hectares in the Province of Limón, called the Autúa-Pirie Reserve, which cannot be converted to private use. The Church of Ujarrás and the Convent of Orosi are historic national monuments in the Province of Cartago.

This "Rich Coast" with its volcanoes and sixteen rivers offers many opportunities for parks and reserves under the Convention. Forest birds are fast diminishing, owing to the clearing of large tracts for the planting of bananas.

### *CUBA*

There are extensive forest laws which protect the forests and regulate the methods of exploiting them. The most important decrees are those of 1923, which govern the system of protective forests and forestry reservations, and 1936, under which the Department of Agriculture is instructed to effect an organization of the virgin forests belonging to the State. The State is also called upon to establish a Forest Park of at least 3,225 acres in each of the Provinces, if possible selecting land unsuited for cultivation. These parks will preserve timber species not plentiful in the country.

On April 12, 1940, the President issued a decree (No. 487) establishing a National Park in the unappropriated "El Cristal", in the Province of Oriente, about 65,000 acres in size.

Hunting and fishing are positively prohibited within the park, within which are found the leading native species of birds. Until a few years ago (1910) there were specimens there of the Imperial Woodpecker (*Campephilus principalis bairdi*) and the "Camao" (*Oropeleia conicepe coniceps*). This is the park that has the flora of Cuba in all its splendor, for it contains representatives of all the timber trees of Cuba as well as of the vascular cryptogams, or Cuban ferns. Besides, one finds growing there practically all of the native species of orchids.

By Decree 1870 of 1936, all of the Zapata Swamp was declared a National Fish and Game Refuge. Here is well represented the flora of the low and marshy lands. Both of these regions furnish sanctuaries where visitors may admire the natural beauties of the Cuban flora and fauna.

Cuba seems very awake to the importance of adding to her existing game laws, parks, and re-

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*Source: T. GILBERT PEARSON, Colombia to Protect its Wild Life (Audubon Mag., Vol. 43, No. 3, May-June, 1941).

**Source: WALLACE W. ATWOOD, 1940: *The Protection of Nature in the Americas* (Pub. No. 50, Instituto Panamericano de Geografía e Historia).

serves. She has made an important start in the areas just mentioned.

She has laws protecting the flamingo and forbidding the export of live wild animals except for scientific purposes for a period of twenty years. She has a permanent Consultive Commission of National Fauna as an adjunct to the Department of Agriculture. They have a grave responsibility, as many Cuban species are fast vanishing because of lack of sanctuaries and their proper administration.

*DOMINICAN REPUBLIC*

This country has a law dating back to 1884 covering the preservation of forests and woods "as a matter of the greatest importance for the nation". This has been followed by other forest laws including one prohibiting the importation of plants, seeds, or fruits which might damage the flora. Forest reserves have been set up.

There is a commission and provisions for the preservation of monuments, historical and archaeological works and objects. In 1913, a law was established setting aside the lands on which are found ancient cities such as La Isabela, and La Vega Real as Historic Parks.

The "Las Matas" National Park, with an area of 49,400 acres, was created in 1933. It is located between the municipalities of San Cristobal and Monseñor Nouel and contains much forest land which is reserved because of its natural beauty. There are plans for a National Park of Jarabacoa to protect the pine forests in this healthful region. A law protecting birds dates back to 1906, and extensive hunting laws regulating seasons and species that can be hunted were passed in 1921 and 1933. This country is definitely handling its wildlife problems and should make a most active and exemplary member of the Convention, which can even further protect the flora and fauna of the Dominican Republic.

*ECUADOR*

Two decrees were adopted in 1934 and 1936 setting up provisions for the protection of plant and animal life in the Galapagos Islands and naming certain islands, some of which include the sole remaining habitat of giant tortoises, Galapagos seals, and penguins, as reservations or national parks for an indefinite period. The difficulty is to enforce this decree in such a remote place visited by foreign yachts and fishermen.

In 1932 the crater of Pichincha was proposed as a national monument, but no action was taken. Up to now Ecuador has no legislation on the protection and preservation of her indigenous wild life outside of the Galapagos decree. It is very much to be hoped that she will carry out the splendid motives of the Galapagos law in suitable areas of Ecuador before they become too opened up. Also, that a way may be found to strengthen the enforcement of the law in the Galapagos.

*EL SALVADOR*

The only provisions regulating hunting are of a general character found in the Agrarian Law (1907). The fauna is typical of the region with game still plentiful in the mountainous districts. The flora is also protected by this law which requires a permit for any clearing operations in forests, and the cutting of trees which are to be used in the construction industry or as firewood. This law applies to public as well as private lands but not to enclosed parks or gardens.

The law requires replanting to replace felled trees, and land holders with over 45 hectares are to set aside one in fifty to be dedicated to the development of forest formations. May 3 is Arbor Day by National Decree, and everyone plants trees on that day.

This small country was the first to ratify the Convention. She now has a chance to set the example by carrying out its provisions.

*GUATEMALA*

The flora of Guatemala is protected by various legislative and administrative measures, the principal one of which is the Forest Law of 1925. Forest reservations also come under the protection of the Agrarian Law of 1936, which maintains necessary natural cover for conserving the sources of water. The forestry program includes all lands with natural forest belonging to the Nation, those belonging to Municipalities, and private landholders who wish to be included.

Guatemala has many areas which would qualify for National Parks. The existing parks are small. They include La Aurora (2,500 acres), Minerva, El Cerro del Carmen, El Cerro del Baul (high vegetation), El Mirador del Filon (high vegetation). In the region found between El Progreso and Zacapa there is land near the highway that might be converted into a national cactus park. It is rich in the following plants: *Cereus, Hylocereus, Lemaireocereus, Cephalocereus, Opuntias, Mamillarias, Nyctocereus*, and the *Cactus maxoni*.

The Volcán de Agua has been suggested as a suitable park location. Here the alpine plants include species of *Senecio, Verbenas*, sages, hornbills (*Erodium*), "castillejas", *Fuchsias, Sedum*, etc., and at a lower elevation pines, oaks, firs, and cypresses. In addition, there are in this area sandworts, "aploppus", *Halenias, Stellarias, Gaultherias, Polygalas*, plumepoppies, cinquefoil, *Pentastemon*, etc. The trees include "tayuyo" (*Chyranthodendrum platanoides*), and "pino enano" (*Pinus donnell smithi*). There also is found the *Weldenia candida*. The region is accessible, and there are fine views from the top of the Volcán de Agua.

Guatemala has established game laws prohibiting big game hunting from February to September, and during the remaining four months only the hunting of males is permitted. This law does not apply to ferocious and injurious animals that may be hunted at all times. The laws also control the sale of furs, birds, and game animals, as well as the taking of reptiles. The "Quetzal", *Pharomacrus mocinno*, the sacred bird of Guatemala, is scarce and is protected by a law of 1897.

As Guatemala is visited by many tourists and has such an unusual variety of altitude and scenery, the country lends itself to the establishment of large numbers of small parks. It is very much to be hoped that the government will see the importance of undertaking such a program.

*HAITI*

There are no National Parks as yet in Haiti, but a National Forest was established in 1936. It comprises the area between the towns of Marmelade, Maissade, Pignon, and Grande Rivière du Nord, and is known as "Forêt Nationale de Saint Raphael", with an area of about 30,000 hectares. There are three important historic monuments constructed by King HENRI CHRISTOPHE, as well as the Fortress of the Crête à Pierrot, the Forte des Platons, etc., which are under government control or protection.

All forests and reserved sites are under the administration of the Technical Service of Agriculture under the 1926 law. The "Trou Caman" has been suggested as a site for a wild life reserve. Haiti, being by far the most densely populated country in the New World, could only hope to set aside small areas as parks or reserves, but these would be of vital importance in order to preserve the fauna and flora. Effective game laws are greatly needed in Haiti, but a large educational program would have to be undertaken to insure their enforcement.

*HONDURAS*

There are no national parks in the country, but the famous Mayan ruins at Copán are of great interest to pre-Colombian archaeologists; and the government has established a National Archaeological Committee, under the Minister of Public Instruction, to suggest suitable measures for the study and restoration of the ruins at Copán and in other parts of the country.

There are no game laws, but as the country is thinly populated and arms and ammunition expen-

sive there is not a great deal of hunting. Forest birds are diminishing due to the clearing of enormous tracts for the cultivation of bananas. This country can well profit by carrying out provisions in the Convention and will find no conflict with existing legislation.

*MEXICO*

In Mexico there is a special office for the administration and supervision of national reservations which include parks, monuments, forests, and wild game sanctuaries. Already there are 48 established parks, part of an elaborate system, with a combined area of 2,079,747 acres. Included in these areas are many regions of great scenic beauty, though little virgin flora and fauna. Preference has been given to the high mountains which ought to be kept under forests.

The majority of the forested National Parks are situated at an altitude greater than 3,000 meters above sea-level, for which reason their forest cover is made up of members of the pine family, of such genera as *Pinus, Cupressus, Abies, Juniperus,* and *Taxodium,* with different species of each one, all of which have been the object of scientific studies and research. In addition, there are to be found species of the families *Fagaceae, Oleaceae, Anacardiaceae, Cupuliferae,* and *Salicaceae,* as the principal forest representatives of the temperate and cold climates. Within the National Parks situated in tropical regions are to be found the characteristic species, of which mention will be made of only a few fine timbers—"cedro" (*Cedrela odorata*), and "mahogany" (*Swietenia mahagoni*), and other hardwood species typical of that climate.

Wild life in Mexico has decreased markedly in the last twenty to thirty years, and continues to diminish, because there is virtually no effective enforcement of existing laws. The mountain sheep and in some regions the black- and white-tailed deer are threatened with extinction, and so they have been given special legal protection from sportsmen and traders.

Mexico has elaborate laws controlling hunting seasons in its various states. There are also laws governing foreign hunters, the traffic in trophies, scientific permits, and the sale of game.

Mexico has a Migratory Bird Treaty with the United States (1936) which carries out the provisions for migratory bird protection called for by the International Convention. Her experience should be very helpful to other American Republics who have not progressed so far in their laws or National Park Program. Let us hope that Mexico will give the Convention its enthusiastic support.

*NICARAGUA*

There are no National Parks, but the government is studying a bill for the purpose of declaring as National Parks such areas as the volcanoes of Momotombo, Masaya, and Mombacho, and the islets of Lake Granada.

There is a Forest Law passed in 1905 prohibiting the clearing of forests that cause the drying up of water springs. This law provides for reforestation and forbids clearing of land by fire.

Among the species of woods that have an economic value and are tending to disappear may be mentioned the "madrono" (*Calycophyllum candidissimum*), "Spanish cedar" (*Cedrela odorata*), the "indigo" (*Indigofera argentea*), the "cacao" (*Theobroma cacao*), and the species of "goosefoot" (*Chenopodium anthelminticum*).

The basic patterns for laws and reserves set forth in the Convention should be most helpful to Nicaragua.

*PANAMA*

There are no parks or botanical gardens in the country. The mahogany, *Swietenia macrophylla,* seems to be the only timber species threatened with extinction at the present time. The nation holds as public lands large tracts of jungle and other lands not yet opened up to settlers.

Barro Colorado Island in the Canal Zone has an area of over six square miles and is covered with virgin forest. There is a scientific laboratory there which was visited by 161 scientists from 56 research institutions during its first eight years of operation. It is now part of the biological area of the Canal Zone and administered under a special act of the United States Congress.

Some of Panama's fauna is seriously threatened with extinction, owing to the absence of laws to protect the indigenous wild life. This is especially true in the case of the tapir, deer, and alligators as well as certain species of monkeys that are widely hunted.

*PARAGUAY*

The government has maintained a Botanical Garden near the village of Trinidad, eight kilometers from Asunción, which is open to the public; but there are no National Parks. The country is sparsely settled with large areas of virgin forest, plain, and swamp land, which afford natural cover for bird and animal life. The game laws are limited to a "Codigo Rural". The country has the least density of population of any of the Central or South American Republics. Let us hope that Paraguay will establish laws and reserves under the International Convention.

*PERU*

The archaeological remains at Chan Chan Pachacamac, and near Cuzco have been set aside by the government. Archaeological monuments are considered the property of the state subject to the protection of the Department of the Central Directory of Archaeology with offices in Lima. There are also regional archaeological offices dependent on this one.

The varying altitude zones from sea level to over 17,000 feet and the increasing number of motor roads hasten the possibility of establishing numbers of parks and reserves. Suggested desirable sites include the Machu-Picchu in the Urubamba valley combining forested mountains and archaeological interest, a grove of woods called Bernapuquio about 30 kilometers from the sea. There are numerous high Andean valleys that might make suitable parks, and then there is the great area of "la montaña" with its Indians and little-known forests with luxuriant flora and varied fauna. Peru has game laws protecting and controlling the killing and export of seals, chinchillas, guanacos, and vicuñas. In spite of these, the chinchilla is very rare, the guanaco not very plentiful, but the numbers of vicuñas are estimated at nearly a million. These are subject to strict control to maintain a proper sex balance in the semi-wild herds. The first vicuña protective law dates back to 1825. The conservation of guano is governed by law in Peru. This dates back to the Inca days when the killing of guano birds, that provided fertilizer, was punishable by death. The laws of 1842 and 1845 forbade destruction of nests, eggs, marine birds, or shooting on guano islands. The guano company employs a trained biologist to study biological problems related to this important industry. There has been, however, a recent attempt to supplant the guano industry with a commercial fish-meal industry.

Let us hope that Peru with its vast resources in scenery, fauna, and flora, will soon initiate a program of National Parks and reserves.

*URUGUAY*

There is the National Park of Carrasco of 950 acres at a beach resort near Montevideo. Beyond this there is a bill pending for the creation of two parks in the department of Rocha, the "Parque del Fuerte de San Miguel" and the "Parque de la Fortaleza de Santa Teresa". The latter might be enlarged to 37,000 acres. These park areas would include examples of both mountain and river valley floras as well as pure stands of palm trees (*Cocos yatay*) on the level and rolling parts.

The greater part of the Uruguayan natural forests are in an advanced stage of deterioration due to irrational cutting, forest fires, and constant grazing. One of the species of the river valley forests, "Nanduhay" (*Prosopis nandubey*), is on its way to

extinction. In 1939, a law was passed to protect the "Yatay" Palm and forbid the extraction of palm honey. The National Tree Promotion Commission has submitted a draft forestry law protecting trees or shrubs said by the Forest Service to be of national interest.

The small area of the country and its devotion to cattle raising led years ago to the killing off of the jaguars, pumas, and "onzas", and the deer and brocket are likewise gone. The "aguaráguazú" (*Chrysocyon brachyurus*), and the "giant anteater", *Myrmecophaga jubata*, are also gone.

Among the species on the way to extinction are the "lobito de arroyo", *Lutra paranensis*, and the "nutria", *Myocastor bonariensis*, which are hunted for their fur.

Problems of protection of birds and mammals are being handled by the National Commission for the Protection of Indigenous Fauna, which has been in existence for eleven years and which has established excellent game laws restricting open seasons. The State has jurisdiction over all species of wild game in the Republic. Licenses are required, and National Hunting Reserves for the propagation of game animals are authorised. Uruguay will surely welcome the International Convention, and will readily fit into it the pattern of excellent laws which she is establishing.

### *VENEZUELA*

In February, 1937, a National Park of some 250,000 hectares was established in the coast range in Aragua State between Turiamo and Chuao, and Lake Victoria and the coast west of Caracas. This is administered by the Forest Service and includes the great forested properties of the late President Gomez. The Venezuelan Government has under consideration the establishment of another National Park in the region of the beautiful Guacharo Cave. This was first visited by the great German scholar, ALEXANDER VON HUMBOLDT. This area includes the habitat of a vanishing bird (*Steatornis caripensis*) that needs protection from persecution.

Hunting in Venezuela is regulated by a law passed in 1936 authorizing Federal control of hunting in the entire country except with regard to the collection of heron plumes, which is governed by special legislation.

Hunting is prohibited during the breeding season, licenses are required, the manner of hunting is regulated, and national hunting reserves are authorized. Venezuela is making an active study of her Forest Conservation and has sent her students to study the way the problem is being handled in the United States. She has shown increasing interest in the conservation of her natural resources and will undoubtedly play a leading part in carrying out the provisions of the International Convention.

### *OTHER AREAS*

There are land areas in Central and South America not included in the American Republics. These include certain islands in the Caribbean, British Honduras, and Dutch, French, and British Guiana. These are not included in this review except that attention should be called to Kaietur National Park (45 square miles), established in 1929 on the Potaro River in the vicinity of the Kaietur Falls in British Guiana.

## *What of the Future?*

If we avoid the field of fisheries, which is a special subject not covered by the Pan American Convention on Nature Protection, we are dealing in this Convention with an international subject which is largely noncontroversial. Everyone agrees that it would be a fine thing if it could be carried out. The burden of enabling it lies with the respective governments.

Is it "utopian" to hope that the day is not too far off when each Republic will point with pride to its roster of National Parks and the scenic beauties that they contain; each Republic will likewise have set aside National Reserves, Nature Monuments, and strict Wilderness Reserves? The game and conservation laws of the various countries will give adequate protection to vanishing species and appropriate protection to migratory birds. A violator of the laws of one country will have his contraband seized and will be appropriately punished if he tries to enter another one of the American Republics. Special attention will have been given to the preservation of natural scenery, wild life, and native populations along the route of the new Pan-American highway. Each country will have the benefits of scientific investigations carried out by specialists in many fields on the fauna and flora of their country. All of the information so gathered will be available for translation into the educational programs of the Republics concerned. Conservation will be taught in the schools.

With the increase in population and land use that is bound to come in the Americas there will be the areas of parks and reserves which will attract tourists and serve for recreational purposes, others that will be perpetual field laboratories for scientific investigations.

Through this Convention we hope that the spiritual values of nature may be preserved for future generations in the New World continents. Some of this will be accomplished automatically because of the physical character of the country, but most of it will depend on the agencies of man for its protection.

No one has better described natural beauty than G. M. TREVELYAN, who says:

> "By the side of religion, by the side of science, by the side of poetry and art, stands natural beauty, not as a rival to these, but as the common inspirer and nourisher of them all, and with a secret of her own besides. . . . It alone makes a common appeal to the sectaries of all our religious and scientific creeds, to the lovers of all our different schools of poetry and art, ancient and modern, and to many more besides these. It is the highest common denominator in the spiritual life of today."

Science, literature, and art have forged strong ties among the American Republics. Let us hope that this Pan American Convention will help to bring about a common interest in the masterpieces of creation in the Americas!

MUSEUM OF COMPARATIVE ZOOLOGY,
HARVARD UNIVERSITY.

D. D. PATERSON: Grazing versus Soiling in the Wet Tropics*:- In the introduction the importance of alternate husbandry or a system of mixed farming for the maintenance of soil fertility and the economic working of farm land is stressed. Any such system of management must mean that fodder and grass crops assume a position of considerable significance in the rotation of crops grown on any farm, and it is pointed

*(A résumé of an article from Tropical Agriculture, October 1941, 18, pp. 191-95). — For an extensive account on grassland problems in Latin America *vide* R. O. WHYTE 1941, The Grasslands of Latin America, CHRON. BOT. 6:443-446.

out that scientific knowledge relative to the propagation, cultivation, manuring and management of tropical forage crops is distinctly limited. At present in the tropics, the establishment of a close grazed perennial sward equivalent in general character and quality to an ordinary English pasture or short term ley apparently is not practicable, and the striking contrast between pasture land of the temperate world and any tropical grazing is emphasized. It is known, however, that with proper management and good cultivation certain perennial tropical grasses such as Guinea grass (*Panicum maximum*) or Elephant grass (*Pennisetum purpureum*) can continue to give very high yields of fairly nutritious roughage over a good number of years. Furthermore, depending on the species, such perennial cultivated tropical grasses may either be used for stall feeding to stock on the soiling system or utilised on a system of rotational grazing. The advantages and disadvantages of these two alternative methods of management are discussed in some detail, and the particular species and conditions which would usually favour any one system are noted.

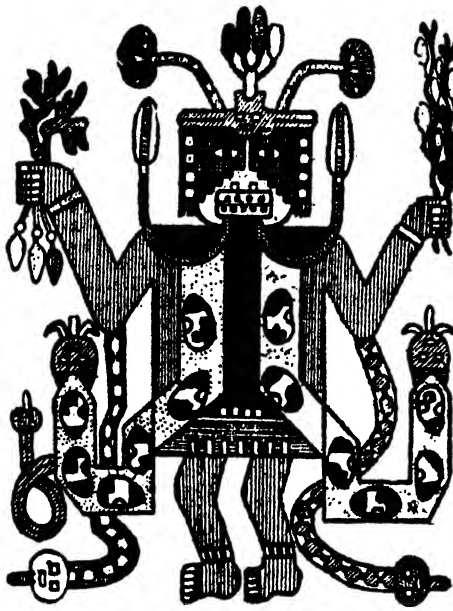
Fundamentally soiling is the more intensive system of management with all the advantages that such a system gives in regard to high yields, effective cultivation, large head of stock per acre and full control of quantity and quality of the stock rations, but with the complementary disadvantages of higher costs of operation and additional expediture on cultivation and manuring.

The need for more extensive and intensive scientific investigation to determine the relative merits of the two methods of management under varying soil and climatic conditions in the tropics is then emphasized. In grazing forage crops, the biotic factor or the influence of the grazing animal on the quality and composition of the pasturage is of primary importance, and this makes the accurate comparison of the soiling and grazing systems peculiarly difficult and technically intricate. It is suggested that comparable estimates under each system for the following three factors would be required:-

The Grazing or Stock Capacity of the Forage Crop.
The Cost per Unit of Marketable Produce.
The Number of Marketable Units produced per acre.

The determination of these values by the ordinary small scale replicated field trial would be extremely difficult or even impossible, and a better method of approach might be by adopting the Pasture Control technique by means of which grassland productivity is evaluated on a farm scale and not from small experimental plots. Briefly, pasture control consists of reducing all the products of any area of grassland—herbage, hay, maintenance, milk production etc.—to one common denominator termed the Grassland Performance Unit or G.P.U. A provisionel scale of values by which the G.P.U. figure of any fodder or grazing area may be assessed is recorded in the original article. Conjointly with such pasture control investigations, scientific research along more customary channels to determine for each species and variety of forage crop, nutritive values, fertiliser requirements, harvesting and pasturing techniques etc. would have to be proceeded with and considerably extended. In particular scientific data measuring the full and exact effect of each type of forage crop on soil structure and soil fertility generally are urgently required if a workable system of alternate husbandry for tropical conditions is to be evolved.

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE,
TRINIDAD, B. W. I.



*Special Supplement*

# PLANT SCIENCE INSTITUTIONS, STATIONS, MUSEUMS, GARDENS, SOCIETIES AND COMMISSIONS IN CENTRAL AND SOUTH AMERICA

The following list of plant science institutions is a revision of the list which we published in March 1942 in CHRONICA BOTANICA VII, No. 2. We did not originally plan to reprint this list until after a thorough revision would have been possible. At the request of many correspondents we decided, however, to revise the list, as well as possible under the present circumstances, for publication in "Plants and Plant Science in Latin America". As soon as possible after the war we will issue an entirely revised list. It may be useful to repeat the short introductory notes which we published with our first list in 1942.

"The following directory is a carefully revised edition of the C. and S. American part of our last World List, as published in CHRONICA BOTANICA IV, no. 4/5 (Sept. 1938). Although its editors do not feel too satisfied with this list, it is the best and most up-to-date list available. It is, without doubt, much better than any of the other lists which have been published recently.

"It took us more than a year to compile this list and we are under great obligation to the Editors of CHRONICA BOTANICA in Central and South America, as well as to at least 200 other colleagues in S., C. and N. America, who have assisted us with the compilation of our list. No information from any source (incl. our previous lists and the lists of the Pan-American Union) has been included unless it has been checked by trustworthy local correspondents.

"We have endeavoured to give all divisions, depts. and sections of the larger and more important institutions.

"There can be no doubt that this list is incomplete and that it contains still several errors. We make a most urgent request to our readers and correspondents to send us all additions and corrections, which seem useful or necessary."

▸ In any one place the various institutions have generally been listed in the following order: Academy Institutes, University Institutes, Technical and Agricultural Colleges, Experiment Stations, Private Research Institutions, Museums and Herbariums, Gardens.

▸ Societies and commissions are listed, in alphabetical order, at the end of each country.

▸ When Departments of Agriculture or Forestry are engaged in research they have been listed as experiment stations. Chemical, geological, bacteriological. etc. institutions have been listed only if they are regularly engaged in research in our field. Small stations and experimental farms without a definite program of research are not always mentioned, particularly not in large countries or if they belong to more important institutions, already listed.

## — *ANTIGUA (W. Indies)* —

**SKERRETS:**
Greencastle Agricultural Experiment Station.

## — *ARGENTINE* —

*Buenos Aires:-*

**ALBERTI:**
Estación Experimental de Alberti.

**BALCARCE:**
Estación Experimental Sudeste.

**BARADERO:**
Vivero Angel Gallardo.

**BARROW:**
Chacra Experimental "Coronel Benito Machado".

**BELLOCQ:**
Estación Experimental de Forrajicultura (Dir. de Agric. de la Prov. de B. Aires).

**BORDENAVE:**
Estación Experimental Bordenave.

**CAMPANA:**
Estación Experimental Agrícola del Delta (Dir. de Agric. de la Prov. de B. Aires).

**CAZON:**
Vivero Eduardo L. Holmberg.

**CORONEL DORREGO:**
Vivero Cristóbal M. Hicken.

**CORONEL VIDAL:**
Escuela de Industrias Rurales "Nicanor Ezeyza".

**DOLORES:**
Escuela de Fruticultura "Osvaldo Magnasco".

**JOSE C. PAZ:**
Estación de Cuarantena de Plantas (Min. de Agr.).

**LA PLATA:**
Universidad Nacional de la Plata:-
- Departamento de Botánica del Instituto del Museo y Escuela Superior de Ciencias Naturales.
- Instituto de Botánica "C. Spegazzini". — Calle 53, No. 477.
- Fac. de Agronomía:-
  - Laboratorio de Agricultura.
  - Laboratorio de Arboricultura General y Frutal.
  - Laboratorio de Botánica Agrícola.
  - Laboratorio de Fitopatología.
  - Laboratorio de Forrajicultura.
  - Laboratorio de Microbiología Agrícola.
  - Laboratorio de Química Agrícola.
  - Jardín Botánico.

Dirección de Agricultura, Ganadería e Industrias de la Provincia de B. Aires. — Pasaje Rocha:-
- Div. de Agronomía.
- Div. de Parques y Viveros.
- Laboratorio de Fitopatología.

**LLAVALLOL:**
Instituto Fitotécnico de Santa Catalina (Fac. de Agronomía, Univ. de La Plata).

**MIRAMAR:**
Estación Dunícola "Florentino Ameghino".

**OLAVARRIA:**
Escuela de Agricultura de Olavarría. — Granja Nacional.

**PATAGONES:**
Vivero Experimental y Administración de Tierras Fiscales "Carlos Spegazzini".

**PERGAMINO:**
Estación Experimental Agrícola de Pergamino.

**SAN ISIDRO:**
Instituto de Botánica "Darwinion" (Ac. Nac. Cien. Ex., Fís. y Nat.).

**TABLADA:**
Vivero y Arboretum de Tablada.

**TANDIL:**
Granja Escuela "Dr. Ramón Santamarina".

**TORNQUIST:**
Estación Experimental Parque Provincial "Sierra de la Ventana" (Dir. de Agric. de la Prov. de B. Aires).

**TRES ARROYOS:**
Chacra Experimental "La Previsión".

**VALDES:**
Escuela Práctica de Agricultura y Ganadería "María Cruz y Manuel L. Inchausti".

*Capital Federal:-*

**BUENOS AIRES:**
Universidad Nacional de Buenos Aires:-
- Fac. de Ciencias Exactas, Físicas y Naturales. — Perú 222:-
  - Laboratorio de Botánica General.
  - Laboratorio de Botánica Sistemática.
  - Laboratorio de Microbiología.
- Fac. de Agronomía y Veterinaria. — Avda. San Martín 4453:-
  - Laboratorio de Agricultura Especial.
  - Laboratorio de Botánica y de Fisiología Vegetal y Fitogeografía.
  - Laboratorio de Fitopatología.
  - Instituto de Frutiviticultura y Silvicultura.
  - Instituto de Genética.
  - Instituto de Industrias Agrícolas: Enología e Industrias Extractivas.
  - Instituto de Industrias Agrícolas: Lechería e Industrias de la Fruta.
  - Laboratorio de Microbiología Agrícola.
  - Instituto de Química e Investigaciones Agropecuarias.
  - Jardín Botánico.
- Facultad de Ciencias Médicas:-
  - Instituto de Botánica y Farmacología. — Córdoba 2182.

Ministerio de Agricultura de la Nación. — Paseo Colón 922:-
- Dirección de Agricultura. — Paseo Colón 922.
  - Lab. de Botánica. — Dársena Norte.
  - Lab. de Química. — Paseo Colón 922.
  - Lab. de Control y Análisis de Harinas. — Paseo Colón 922.
  - Oficina de Control y Fomento del Cultivo del Olivo. — Paseo Colón 922.
  - Div. Viveros.
- Dirección de Agronomías Regionales.
- Dirección de Algodón.
- Dirección de Cereales, Lino y Forrajes:-
  - Sección Genética y Contralor de Criaderos.
  - Red Oficial de Ensayos Territoriales.
  - Lab. Experimental de Molinería y Panificación.
- Dirección de Estaciones Experimentales.
- Dirección Forestal.
- Dirección de Frutas, Hortalizas y Flores.
- Dirección de Industrias Químicas.
- Dirección del Instituto de Sanidad Vegetal. — Paseo Colón 922:-
  - Div. de Fitopatología.
  - Div. de Análisis y Clasificación Comercial de Semillas.
  - Inspección Portuaria de Vegetales.
  - Sección Reconocimiento y Control Sanitario.
- Dirección de Parques Nacionales. — Sante Fé 690.
  - Museo de la Patagonia "Perito Francisco P. Moreona".
- Dirección de Vitivinicultura.
- Lab. de Fisiología Vegetal del Dirección de Paseos Públicos. — Santa Fé 3951.
- Instituto de Suelos y Agrotecnia.
- Instituto Nacional del Tabaco. — Maipú 241.

Instituto Bacteriológico del Departamento Nacional de Higiene. — Vélez Sarsfield 563.

Agricultural Laboratory of the Great Southern and Western Railroads. — Plaza Constitución; Cas. 109.

Centro Vitivinícola Argentino. — Bolívar 390, III.

Centro Azucarero Argentino. — Reconquista 336, Piso 12.

Sección Química Agrícola Bayer. — Coronel Díaz 2110, Piso 2.

Sección Botánica del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia". — Parque Centenario; Cas. 10, Suc. 5, Chubut 450.

Jardín Botánico Municipal. — Santa Fé 3951, Palermo.

*Chaco:-*

**LAS BREÑAS:**
Estación Experimental Algodonera.
**PRESIDENTE ROQUE SÁENZ PEÑA:**
Estación Experimental Algodonera.
**RESISTENCIA:**
Laboratorio de Fitopatología.

*Córdoba:-*

**BELL-VILLE:**
Escuela de Agricultura y Ganadería de Bell-Ville.
**RAMON CARCANO:**
Estación Experimental "Juan Laplacette".
**CORDOBA:**
Universidad Nacional de Córdoba:-
- Facultad de Ciencias Exactas, Físicas y Naturales:-
  - Lab. de Botánica. — Vélez Sársfield 249.
  - Museo de Botánica. — Vélez Sársfield 249.
- Facultad de Ciencias Médicas:-
  - Lab. de Botánica y Micrografía Vegetal de la Escuela de Farmacia. — Obispo Trejo y Sanabria 241.

Escuela de Agricultura y Ganadería de Córdoba.
Laboratorio de Fitopatología (Min. de Agr.).
**MANFREDI:**
Estación Experimental de Manfredi.
**VILLA DOLORES:**
Estación Experimental Tabacalera.

*Corrientes:-*

**BELLA VISTA:**
Laboratorio de Fitopatología.
**GOYA:**
Estación Experimental Tabacalera.

*Entre Ríos:-*

**COLONIA YERUA:**
Estación Experimental de Yeruá.
**CONCORDIA:**
Estación Experimental de Concordia.
**LAS DELICIAS:**
Escuela de Agricultura de las Delicias y Campo Anexo de Nogoyá.
**PARANA:**
Sección Fitotécnia, Departamento de Agricultura y Ganadería. — España 115.
Museo de Entre Ríos. — 25 de Mayo 66; Cas. 867.
**TEZANOS PINTO:**
Escuela Normal de Maestros Rurales "J. Bautista Alberdi".
Estación Experimental de Alberdi.
**VIALE:**
Escuela Agropecuaria de Estación Viale.
**VILLAGUAY:**
Escuela Agropecuaria de Villaguay.

*Formosa:-*

**FORMOSA:**
Chacra Experimental de Kilómetro 190 de la Navegación del Río Bermejo.

*Jujuy:-*

**PERICO:**
Sub-Estación Experimental Tabacalera.

*Mendoza:-*

**MENDOZA:**
Universidad Nacional de Cuyo. — Rivadavia 125:-
- Facultad de Agronomía:-
  - Laboratorio de Fisiología y Genética.
  - Laboratorio de Botánica.

Dirección de Industrias y Fomento Agrícola (Min. de Econ.):-
- Instituto Técnico de Investigaciones y Orientación Económica de la Producción.
- Sección Antifiloxérica. — San Martin 1148.

Laboratorio de Fitopatología (Min. de Agr.).
Escuela Nacional de Agricultura y Enología.
**SAN RAFAEL:**
Sección Antifiloxérica de la Dirección de Industrias y Fomento Agrícola.

*Misiones:-*

**CERRO AZUL:**
Estación Experimental Tabacalera.
**SAN IGNACIO:**
Estación Experimental de Loreto.
**ZAIMAN:**
Escuela de Agricultura del Zaimán.

*La Pampa:-*

**GENERAL PICO:**
Estación Experimental de General Pico.
**GUATRACHE:**
Estación Experimental de Guatrache. .

*Río Negro:-*

**BARILOCHE:**
Parque Nacional de Nahuel Huapí.
**CINCO SALTOS:**
Chacra Experimental de Cinco Saltos.
**CORONEL JUAN F. GOMEZ:**
Laboratorio de Fitopatología.
**FUERTE GENERAL ROCA:**
Estación Experimental de Coronel Juan F. Gómez.

*Salta:-*

**CHICOANA:**
Estación Experimental Tabacalera.
**CORONEL MOLDES:**
Estación Experimental de Puerta de Díaz.
**GÜEMES:**
Estación Experimental de Güemes.
**SALTA:**
Laboratorio de Fitopatología. — España 862 (2. Piso).

*San Juan:-*

**ALTO DE SIERRA:**
Estación Experimental de Alto de Sierra.
Laboratorio de Fitopatología.
**DESAMPARADOS:**
Escuela de Agricultura e Industria de la Fruta de San Juan.

*Santa Cruz:-*

**SAN JULIAN:**
Estación Experimental de Cañadón León.

*Santa Fé:—*

**ANGEL GALLARDO:**
Instituto Experimental Agrícola y Ganadero de la Provincia de Santa Fé.
**CASILDA:**
Escuela dé Agricultura y Campo anexo Oliveros.
**RAFAELA:**
Estación Experimental de Rafaela.
**ROSARIO:**
Facultad de Ciencias Médicas y Farmacia de la Universidad Nacional del Litoral. — Santa Fé 3100.
**SALADERO CABRAL:**
Estación Experimental Algodonera de Colonia Mascías.
**SANTA FE:**
Universidad Nacional del Litoral:-
- Facultad de Química Industrial y Agrícola.
- Instituto de Edafología.
- Instituto de Experimentación é Investigaciones Agropecuarias.
- Instituto de Investigaciones Microquímicas.
- Jardín Botánico.

*Santiago del Estero:-*

**AÑATUYA:**
Estación Experimental Algodonera.
**LA BANDA:**
Estación Experimental Algodonera.

*Tucumán:-*

**TUCUMAN:**
Universidad Nacional:-
- Instituto Miguel Lillo. — Miguel Lillo 205.
- Lab. de Botánica Farmacéutica. — Ayacucho 472.
- Lab. de Farmacognosia. — C. Alvarez 763.

Lab. de Sistemática Microbiológica (Fac. de Bioquímica). — C. Alvarez 768.
Lab. de Microbiología Industrial.
Escuela de Agricultura. — Las Heras 1545.
Estacion Experimental Agricola de la Provincia de Tucumán.

VILLA ALBERDI:
Estación Experimental Tabacalera.

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Academia Nacional de Agronomía y Veterinaria. — Calle Santa Fé 1145, Buenos Aires.
Academia Nacional de Ciencias Exactas, Físicas y Naturales. — Calle Perú 274, Buenos Aires.
Academia Nacional de Ciencias. — Córdoba.
American Society of Agricultural Sciences, Argentine Chapter. — Sec.: R. García M., Junta Nacional del Algodón, Buenos Aires.
Asociación Argentina del Frío. — Buenos Aires.
Asociación Argentina para el Progreso de las Ciencias. — Buenos Aires.
Asociación Bioquímica Argentina. — Buenos Aires.
Centro Argentino de Ingenieros Agrónomos. — Calle Arenales 1678, Buenos Aires.
Centro de Estudiantes de Agronomía. — Villa Ortúzar, Buenos Aires.
Centro de Estudiantes de Ciencias Naturales. — Calle Perú 222, Buenos Aires.
Sociedad Amigos del Arbol de la República Argentina. — Sr. A. Ruiz Hereno, Buenos Aires.
Sociedad Argentina de Agronomía. — Calle Santa Fé 1145, Buenos Aires.
Sociedad Argentina de Biología. — Ayacucho 1129, Buenos Aires.
Sociedad Argentina de Ciencias Naturales (Physis). — Calle Perú 294, Buenos Aires.
Sociedad Argentina de Horticultura. — 25 de Mayo 11, Buenos Aires.
Sociedad de Biología de Córdoba. — Colón 687, Córdoba.
Sociedad Científica Argentina. — Santa Fé 1145, Buenos Aires.
Sociedad Forestal Argentina. — Buenos Aires.
Sociedad Nacional de Biología de Argentina. — Calle Santa Fé 1171, Buenos Aires.
Sociedad Nacional de Fruticultura. — Florida 470, Buenos Aires.
Sociedad Rural Argentina. — Florida 460, Buenos Aires.
Sociedad Rural de Cerealistas. — Córdona 1154, Rosario.
Sociedad Rural de Rosario. — Boulevard Oroño 2498, Rosario.
Sociedad Rural de Santa Fé. — Boulevard Pellegrini 3292, Santa Fé.

## — *BARBADOS (W. Indies)* —

BRIDGETOWN:
Department of Science and Agriculture.
British West Indian Central Sugar Cane Breeding Station.

## — *BOLIVIA* —

CHULUMANI (Yungas de la Paz):
Granja Agrícola de Experimentación (Dir. Gen. Agric.).

COCHABAMBA:
Universidad Autónoma de Cochabamba:-
Depto. de Botánica y Herbario.
Escuela Superior de Agronomía:-
Laboratorio de Fitopatología.
Estación Experimental de Genética. — Granja "Las Cuadras".
Instituto Nacional de Bacteriología. — Miraflores.

LA PAZ:
Dirección General de Agricultura y Ganadería.
Sección de Sanidad Vegetal.
Museo Nacional "Tihuanacu".

SANTA CRUZ:
Escuela Práctica de Agricultura y Ganadería.
Granja Experimental "Palermo".

TARIJA:
Granja Experimental del "Tejar".

TRINIDAD:
Granja Experimental de Agricultura.

• • •

Sociedad de Ingenieros Agrónomos. — La Paz.
Sociedad Geográfica de La Paz. — Ap. 685, La Paz.

## — *BRAZIL* —

*Alagôas:-*

MACEIÓ:
Secção de Fomento Agrícola. — Rua Sá e Albuquerque 546.

*Amazonas:-*

MANAOS:
Estação Agronómica. — Rua Teodoreto Souto 213.

*Baía:-*

ALAGOINHAS:
Estação Experimental de Fruticultura.

BAÍA:
Escola Agronómica da Baía. — Monte Serrat.
Secretaria da Agricultura:-
Serviço de Fomento da Produção Vegetal. — Praça Castro Alves.
Departamento de Agronomia. — Praça Castro Alves.
Serviço de Defesa Sanitaria Vegetal. — Monte Serrat.
Instituto do Cacau de Baía. — Avenida de Hespanha, Caixa postal 228.
Instituto Baiano do Fumo. — Praça da Inglaterra.
Serviço de Reflorestamento da Viação Férrea Federal Leste Brasileiro. — Rua Miguel Calmon.

RETIRO:
Horto Florestal do Retiro.

SANTO ANTONIO DE JESUS:
Estação Experimental de S. Antonio de Jesús.

*Ceará:-*

FORTALEZA:
Escola de Agronomia do Ceará.
Estação Experimental do Estado do Ceará.
Secção de Botánica do Museu Rocha.

*Distrito Federal:-*

DEODORO:
Estação Experimental de Plantas Forrageiras do Instituto de Biologia Animal (Min. da Agric.).
Estação Experimental de Pomologia do I. E. A.

RIO DE JANEIRO:
Faculdade de Ciencias da Universidade:-
Departamento de Botánica.
Faculdade de Ciencias Médicas:-
Instituto Nacional de Botánica e Farmacologia "Julio A. Roca".
Laboratorio de Biofísica.
Ministerio da Agricultura:-
C. N. E. P. A.: Centro Nacional de Ensino e Pesquisas Agronómicas:-
Escola Nacional de Agronomia. — Av. Pasteur:-
Cadeira de Botánica Agrícola: Anatomia, Fisiologia e Sistemática.
Cadeira de Agricultura Geral e Genética Vegetal.
Cadeira de Agricultura e Genética Especialisadas.
Cadeira de Fitopatologia e Microbiologia Agrícola.
Cadeira de Horticultura e Silvicultura.
Laboratorio Central de Enologia.
Instituto de Química Agrícola. — Rua Jardim Botánico 1024.
Instituto de Ecologia Agrícola.
Instituto de Experimentação Agrícola.
Instituto Nacional de Oleos. — Praça Marechal Ancora.
Serviço Florestal do Brasil:-
Secção de Botánica.
Jardim Botánico.
Secção de Parques Nacionais.
Secção de Silvicultura.
Secção de Tecnologia de Produtos Florestais.
Serviço de Irrigação e Reflorestamento.

Serviço de Fruticultura.
Serviço de Plantas Têxteis.
Serviço de Meteorologia.
Laboratorio de Sementes.
D. N. P. V.: Departamento Nacional da Produção Vegetal:-
Div. do Fomento da Produção Vegetal. — Rua da Misericordia.
Secção de Plantas Texteis.
Div. de Defesa Sanitaria Vegetal. — Rua da Misericordia.
Secção de Agrostologia e Alimentação dos Animais, Instituto de Biologia Animal (Min. da Agric.).
Inspetoria Federal de Obras contra as Sêcas (Min. da Viação e Obras Públicas). — Av. Nilo Peçanha 155, I.
Departamento Nacional do Café. — Edificio da Noite 22.
Instituto do Açúcar e do Alcool. — Rua General Camara 19, IV; Caixa postal 420.
Depto. de Micologia do Instituto Oswaldo Cruz. — Caixa p. 926.
Divisão de Botánica do Museu Nacional. — Quinta da Boa Vista.

*Espírito Santo:-*

COLATINA:
Estação Experimental de Goytacazes.

*Goiás:-*

GOIANIA:
Secção de Fomento Agricola. — Praça 24 de Outubro 21.

*Mato Grosso:-*

CUIABÁ:
Secção de Fomento Agrícola. — Praça 13 de Maio 4.

*Minas Gerais:-*

BELO HORIZONTE:
Escola de Agronomia e Veterinaria de Belo Horizonte.
Estação Experimental Agrícola do Estado:-
Secção de Botánica.
Secção de Fitopatologia.
Secção de Genética.
Serviço Florestal do Estado.
CALDAS:
Estação Experimental de Enologia do I. E. A.
CORONEL PACHECO:
Estação Experimental do I. E. A.
LAVRAS:
Escola Superior de Agricultura.
PARA DE MINAS:
Fazenda-Escola Florestal.
PATOS:
Estação Experimental do I. E. A.
VIÇOSA:
Escola Superior de Agricultura e Veterinaria.

*Pará:-*

BELÉM:
Instituto Agronómico do Norte:-
Secção de Genética.
Secção de Solos.
Secção Biológica.
Secção de Tecnologia.
Secção de Experimentação Agrícola.
Museu Goeldi de História Natural e Etnografia. — Av. Independencia 360.
Museu Comercial. — Praça da República.
BRAGANÇA:
Estação Experimental.

*Paraíba:-*

ALAGOINHA:
Estação Experimental do I. E. A.
AREIA:
Escola de Agronomia do Nordéste.
JOÃO PESSOA:
Secretaria da Agricultura.
Laboratorio de Fibras do I. E. A.

*Paraná:-*

CAMBARÁ:
Estação Experimental de Plantas Texteis.
CURITIBA:
Estação Experimental do I. E. A.
Instituto de Biologia Agrícola e Animal do Estado:-
Secção de Bacteriologia e Industrias de Fermentação.
Secção de Botánica e Citologia.
Secção de Fitopatologia e Entomologia.
Secção de Química Agrícola e Tecnológica.
Instituto do Mate. — Caixa p. 331.
Instituto Técnico de Agronomia, Veterinária e Química.
Escola Agronómica do Paraná.
IGUASSU:
Parque Nacional.
PONTA GROSSA:
Estação Experimental de Criação.

*Pernambuco:-*

CURADO:
Estação Experimental do I. E. A.
ITAPIREMA (Goiana):
Estação Experimental de Fruticultura Tropical.
RECIFE:
Escola Superior de Agricultura de Pernambuco.
Instituto de Pesquisas Agronómicas:-
Secção de Botánica.
Secção de Patologia Vegetal.
Secção de Química Agrícola.
Secção de Sólos.
Jardim Botánico.
Fomento Agrícola Federal. — Rua de S. João:-
Secção do Algodão e Outras Plantas Texteis.
Secção do Café.
Secção de Plantas Alimentares.
Estação Experimental de Fruticultura. — Bongí.
Serviço de Defeza Sanitaria Vegetal.
Serviço Estadual de Algodão e Outras Plantas Texteis.
SURUBIM:
Estação Experimental de Algodão.
TAPERA*:
Subestação Experimental de Cana de Açúcar.
VARZEA:
Estação Experimental de Cana de Açúcar.
VITORIA (Cedrinho):
Estação Experimental de Citricultura.

*Piauí:-*

TEREZINA:
Secção de Fomento Agrícola. — Rua Coelho Rodriguez 26.

*Rio Grande do Norte:-*

SERIDO:
Estação Experimental do I. E. A.

*Rio Grande do Sul:-*

BENTO GONÇALVES:
Estação Experimental de Enologia do I. E. A.
CAXIAS:
Estação Experimental de Viticultura e Enologia.
PASSO FUNDO:
Estação Experimental do I. E. A.
PELOTAS:
Escola de Agronomia "Elizeu Maciel".
Estação Experimental de Fruticultura.
PORTO ALEGRE:
Universidade de Porto Alegre:-
Gabinete de Historia Natural do Colegio Universitario.
Escola de Agronomia e Veterinaria:-
Cadeira de Agricultura.
Cadeira de Botánica.
Cadeira de Fitopatologia.
Cadeira de Genética.
Gabinete de Historia Natural do Colegio N. S. das Dores.
Instituto Experimental de Agricultura.
Laboratorio de Biologia Agrícola da Secretaria da Agricultura.

Museu de Porto Alegre, Secção de Botânica.
Herbário Anchieta. — R. Duque de Caxias 1247.
Herbário do Ginásio N. S. das Dores. — R. Andradas 769.
Diretoria de Parques e Jardins da Prefeitura.
TUPACERETAN:
Laboratorio de Agrostologia, Posto Zootécnico da Terra.

*Rio de Janeiro:-*

CAMPOS:
Estação Experimental do I. E. A.
ITATIAIA:
Parque Nacional.
NITEROI:
Secção de Fomento Agricola. — Rua Visconde de Rio Branco 359.
SÃO BENTO:
Secção de Investigações Fitosanitarias da Divisão de Defesa Sanitaria Vegetal do Depto. Nacional da Produção Vegetal.

*Santa Catarina:-*

CANOINHA:
Instituto Agronómico.
FLORIANOPOLIS:
Serviço de Experimentação e Fomento da Produção Vegetal:-
Diretoria de Química Agrícola e Tecnológica.
Diretoria de Defesa Sanitaria Vegetal.
Diretoria de Ecologia Agrícola.
Diretoria Florestal.
(Instituto Agronómico. — em Canoinha).
Jardim Botânico.
Horto Florestal.
INDAYAL:
Instituto Professional Agrícola.
JOINVILLE:
Instituto do Mate. — Caixa postal 15.
LAGES:
Estação Fitotécnica de Lages.
PERDIZES:
Estação Experimental de Viticultura, Enologia e Frutas de Clima Temperado (Min. da Agric.).
POÇO PRETO:
Campo Experimental.
RIO CAÇADOR:
Estação Experimental do I. E. A.

*São Paulo:-*

ALTO DA SERRA DE PARANAPIACABA:
Estação Biológica do Departamento de Botânica do Estado. — Caixa Postal 2164, São Paulo.
BORACEIA:
Estação Experimental do I. Agronómico do Estado.
BOTUCATU:
Estação Experimental Central de Café.
CAMPINAS:
Instituto Agronômico (Divisão de Experimentação e Pesquisas do Departamento da Produção Vegetal do Estado):-
Subdivisão de Genética:-
Secção de Genética.
Secção de Citologia.
Secção de Introdução de Plantas Cultivadas.
Subdivisão de Horticultura:-
Secção de Citricultura e Frutas Tropicais.
Secção de Olericultura e Floricultura.
Secção de Viticultura e Frutas de Clima Temperado.
Subdivisão de Plantas Texteis:-
Secção de Algodão.
Secção de Plantas Fibrosas.
Subdivisão de Engenharia Rural:-
Secção de Mecânica Agrícola.
Secção de Irrigação, Drenagem e Defesa Contra a Inundação.
Secção de Conservação do Solo.
Subdivisão de Estações Experimentais.
Estação Experimental Central do I. Agronómico do Estado.
Fazenda Experimental "Mato Dentro" do I. Biológico do Estado.
EST. BUENO DE ANDRADA (Araraquara):
Serviço Florestal da E. F. Araraquara.
IPANEMA:
Estação Experimental do I. E. A.
JUNDIAI:
Estação Experimental de Enologia do I. E. A.
Estação Experimental do I. Agronómico do Estado.
LIMEIRA:
Estação Experimental do I. Agronómico do Estado.
PINDORAMA:
Estação Experimental do I. Agronómico do Estado.
PIRACICABA:
Escola Sup. de Agricultura "Luiz de Queiroz" (Univ. de São Paulo):-
Cadeira de Agricultura Especial e Genética aplicada.
Cadeira de Agricultura Geral.
Cadeira de Botânica Geral e Descritiva.
Cadeira de Química Agrícola.
Cadeira de Citologia e Genética Geral.
Cadeira de Fitopatologia e Microbiologia Agrícola.
Cadeira de Horticultura.
Secção Técnica de Horticultura.
Estação Experimental do I. Agronómico do Estado. — Caixa postal 28.
Sindicato Agronómico do E. de S. Paulo, Depto. Científico.
RIBEIRÃO PRETO:
Estação Experimental do I. Agronómico do Estado.
RIO CLARO:
Companhia Paulista:-
Serviço Florestal.
Museu Florestal.
SÃO PAULO:
Faculdade de Filosofia, Ciencias e Letras da Universidade:-
Departamento de Botânica. — Caixa postal 2926.
Secção de Genética.
Instituto Biológico (Departamento da Defeza Sanitaria da Agricultura):-
Div. de Biologia:-
Secção de Parasitologia Vegetal.
Secção de Fisiologia Vegetal.
Secção de Química.
Div. de Defesa Vegetal:-
Secção de Defesa Fitosanitaria.
Secção de Vigilancia Sanitaria Vegetal.
Secção de Fitopatologia.
Departamento de Botânica do Estado. — Av. Paulista 2806; Caixa postal 2164.
Parque e Jardim Botânico do Estado.
Secção de Botânica do Depto. de Indústria Animal. — Agua Branca.
Serviço Florestal do Estado. — Caixa postal 1322.
Museu Florestal.
Secção de Introdução de Essencias.
Horto Florestal da Cantareira.
Serviço Florestal da Sorocabana.
Instituto Butantan. — Caixa postal 65.
Secção de Botânica Médica.
Laboratorio Bacteriológico e Hidrobiológico da Repartição de Aguas e Exgotos do Estado. — Rua Riachuelo 115.
Laboratorio Paulista de Biologia.
Museu Paulista.
SÃO ROQUE:
Estação Experimental do I. Agronómico do Estado.
SOROCABA:
Estação Experimental do I. Agronómico do Estado.
TATUI:
Estação Experimental do I. Agronómico do Estado.
TIETE:
Estação Experimental do I. Agronómico do Estado.
TUPI:
Estação Experimental do I. Agronómico do Estado.

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*N.B.:- The "Escola Superior de Agricultura S. Bento" has been closed.

**UBATUBA:**
**Estação Experimental do I. Agronómico do Estado.**

*Sergipe:-*

**ARACAJÚ:**
**Secção de Fomento Agrícola.** — Rua Laranjeiras 131.

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**Academia Brasileira de Ciencias.** — Caixa p. 229, Rio de Janeiro.
**American Society of Agricultural Sciences, Brazilian Chapter.** — Sec.: Prof. V. Duarte Silveira, Escola Nacional de Agronomia, Rio de Janeiro.
**Sociedade Amigos da Flora Brasílica.** — Av. Paulista 2086, São Paulo.
**Sociedade Baiana de Historia Natural.** — Victoria 221, Baía.
**Sociedade de Biologia de São Paulo.** — Caixa p. 2921, São Paulo.
**Sociedade de Biologia do Rio de Janeiro.** — Rio de Janeiro.
**Sociedade Brasileira de Agronomia.** — Praça 15 de Novembro, 38a, Edificio Cardoso, Rio de Janeiro.
**Sociedade Brasileira de Biologia.** — Rio de Janeiro.
**Sociedade Brasileira de Botânica.** — Jardim Botânico, Rio de Janeiro.
**Sociedade Científica de São Paulo.** — Rua 15 de Novembro, 20, 2° Andar, São Paulo.
**Sociedade Fluminense de Orchideas.** — Sec.: João Saturnino de Sousa. . . .
**Sociedade Nacional de Agricultura.** — Rua 1. de Março, 15, Rio de Janeiro.
**Sociedade Rural Brasileira.** — Caixa p. 2889, São Paulo.

## — BRITISH GUIANA —

**GEORGETOWN:**
**Dept. of Agriculture:-**
- **Rice Experiment Station.**
- **Jenman Herbarium.**
- **Botanic Gardens.**

**Forest Department.**

**SOPHIA:**
**Sugar Experiment Station.**

## — BRITISH HONDURAS —

**BELIZE:**
**Department of Agriculture.**
**Forest Department.** — P. O. Box 181.
**Jubilee Library.**

**STANN CREEK VALLEY:**
**Agricultural Experiment Station.**

## — BRITISH VIRGIN ISLANDS — (West Indies)

**TORTOLA:**
**Department of Agriculture.**

## — CHILE —

**CAUQUENES (Maule):**
**Estación Experimental de Genética Fitotécnica.** — Casilla 165.

**CHILLAN (Ñuble):**
**Estación Experimental de Genética Fitotécnica.** — Cas. 426.

**COLLIPULLI:**
**Estación Experimental de Genética Fitotécnica.** — Cas. 8.

**CONCEPCION:**
**Universidad de Concepción:-**
- **Instituto de Botánica y Farmacognosia.** — Casilla 1480.
- **Laboratorio de Farmacia.** — Casilla 1480.
- **Departamento Agrícola.** — Casilla 723.

**Sección de Botánica del Museo de Concepción.** — Pedro de Valdivia 701; Casilla 779.

**CURICO:**
**Estación Experimental Frutícola "El Boldo".** — Casilla 352.

**IQUIQUE:**
**Campo Experimental para el Riego de la Pampa Tamarugal.** — Caja de Colonización y Apizpado de Iquique.

**LA SERENA:**
**Sub-Estación Experimental de Arboricultura Forestal.** — Casilla 322.

**LOS ANDES:**
**Estación Experimental de Genética Fitotécnica.** — Cas. 7.
**Estación Experimental de Arboricultura Frutal.**

**LOS ANGELES (Aconcagua):**
**Estación Experimental de Genética Fitotécnica.** — Cas. 143.

**MAGELLANES:**
**Museo Regional Salesiano del Territorio Magellanes.**

**OSORNO:**
**Estación Experimental de Genética Fitotécnica.** — Cas. 340.

**OVALLE (Coquimbo):**
**Estación Experimental de Genética Fitotécnica Fundo "Aníbal de Tuquí".** — Casilla 7.

**PAINE:**
**Estación Experimental de Genética Fitotécnica Fundo "Viluco".** — Casilla 4088, Santiago.

**PUERTO OCTAY (Llanquihue):**
**Estación Experimental de Genética Fitotécnica Fundo "Centinela".** — Casilla 340, Osorno.

**PUNTA ARENAS:**
**Estación Experimental "Río de los Ciervos".** — Casilla 199, Magellanes.
**Museo de los PP. Salesianos.** — Casilla 237.

**SANTIAGO:**
**Universidad de Chile.** — Av. B. O'Higgins 1058.
- **Escuela de Agronomía.** — Casilla 1004.
- **Vivero Forestal.** — Casilla 1004.

**Escuela Práctica de Agricultura.** — Av. Ecuador 3445; Casilla 5577.
**Escuela de Química y Farmacia.** — Av. Vicuña Mackenna 20; Casilla 6084.
**Instituto Pedagógico:-**
- **Sección de Ciencias Naturales y Herbario.** — Av. O'Higgins 2297; Casilla 147.

**Universidad Católica:-**
- **Facultad de Agronomía e Industrias.** — Casilla 114 D.
- **Escuela Agrícola de Macul.** — Casilla 114 D.

**Ministerio de Agricultura:-**
- **Depto. Agrológico de la Caja de Colonización Agrícola.**
- **Depto. de Arboricultura y Tecnología Frutal.** — Casilla 5560.
- **Depto. de Defensa y Sanidad Pecuaria.**
  - **Sección Plantas Venenosas.** — Casilla 4527 (Correo 2).
- **Depto. de Enología y Viticultura.** — Casilla 2377.
- **Depto. de Genética Fitotécnica.** — Casilla 4088.
  - **Herbarium.** — Casilla 4088.
  - **Estación Genética.** — Hacienda El Sauce.
- **Depto. de Química y Suelos.** — Casilla 5523 (Correo 6).
- **Depto. de Sanidad Vegetal.** — Casilla 4647.

**Ministerio de Tierras y Colonización.** — Teatinos 254:-
- **Servicio de Bosques.** — Palacio de la Moneda.
- **Caja de Colonización Agrícola.** — Huerfanos 1338.

**Laboratorio Petrográfico del Depto. de Minas y Petróleos.** — Av. Beauchef 850.
**Instituto Bacteriológico de Chile.** — Borgoño 1470.
**Instituto Biológico y Estación Experimental de la Sociedad Nacional de Agricultura.** — Fdo Lazcano 1502; Cas. 40 D.
**Hacienda la Rinconada de Maipú.** — Casilla 1004.
**Departamento Agronómico de la Corporación de Ventas de Salitre y Yodo.** — Casilla 13200.
**Departamento Agronómico de la Corporación de Fomento a la Producción.** — Casilla 3886.
**Instituto Industrial de la Madera.** — Casilla 137 D.
**Campo Experimental Frutícola.** — Casilla 5560.
**Sección Botánica, Museo de Historia Natural.** — Cas. 787.

Museo Nacional de Botánica Aplicada (en proyecto). — Defensa de la Raza, Moneda 1824.
Herbario del Liceo Alemán. — Moneda 1661.
Jardín Botánico (en proyecto). — Quinta Normal.

TEMUCO:
Estación Experimental de Genética Fitotécnica. — Cas. 41.
Museo Araucano de Temuco. — Cas. 481.

VALLENAR:
Estación Experimental Frutícola.

VALPARAISO:
Universidad Técnica "Federico Santa María". — Cas. 110-V.
Estación Experimental Frutícola e Industrial. — Cas. 78.
Estación Experimental de Genética Fitotécnica. — Casilla 20.
Museo de Historia Natural. — Av. Errázuriz 254.

VICUÑA (Elqui):
Estación Experimental de Arboricultura Frutal.

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Academia Chilena de Ciencias Naturales. — Casilla 114 D, Santiago.
American Society of Agricultural Sciences, Chilean Chapter. — Sec.: M. Elgueta G., Depto. de Genética Fitotécnica, Min. de Agricultura, Santiago.
Deutscher Wissenschaftlicher Verein. — Cas. 3214, Santiago.
Seminario Entomo-Fitopatológico. — Casilla 4109, Santiago.
Sociedad Agronómica de Chile. — Casilla 4528, Santiago.
Sociedad Amigos del Arbol. — Casilla 1935, Santiago.
Sociedad de Biología de Concepción. — Casilla 29, Concepción.
Sociedad de Biología de Santiago. — Universidad Nacional, Santiago.
Sociedad Chilena de Fitoquímica y Botánica Aplicada. — Casilla 6084, Santiago.
Sociedad Chilena de Historia Natural. — Casilla 787, Santiago.
Sociedad Chilena de Microbiología e Higiene. — Casilla 48, Santiago.
Sociedad Científica de Chile (Société Scientifique du Chili). — Casilla 696, Santiago.
Sociedad Científica de Valparaíso. — Cas. 1802, Valparaíso.
Sociedad Nacional de Agricultura. — Tenderini 187; Casilla 40 D, Santiago.

## — *COLOMBIA* —

ANDALUCIA (El Valle):
Granja Experimental de Cacao.

ARMERO (Tolima):
Estación Agrícola Experimental de Algodón.

BARRANQUILLA (Atlántico):
Granja Experimental Algodonera del Atlántico.
Museo de Ciencias Naturales, Colegio Biffi.
Museo Departamental del Atlántico.

BOGOTA (Cundinamarca):
Instituto de Ciencias Naturales de la Universidad Nacional:-
- Sección Botánica. — Apartado No. 2535.
- Herbario Nacional Colombiano. — Apartado No. 2535.

Sección Botánica del Instituto de la Salle. — Calle 11, No. 1/69.
Ateneo de Altos Estudios (Min. de la Educ.).
Ministerio de la Economía:-
- Sección de Biología Vegetal:-
  - Servicio de Botánica.
  - Servicio de Fitopatología.
- Sección de Bosques.
- Depto. de Tierras.
  - Museo Forestal.

Laboratorio Químico Nacional de Análisis e Investigación.
Departamento Técnico, Federación Nacional de Cafeteros de Colombia.

BUGA (Valle):
Granja Experimental Algodonera.

CAJICA (Cundinamarca):
Estación Central de Papa.

CALI (Valle):
Escuela Superior de Agricultura Tropical.

CARTAGENA (Bolívar):
Sección Botánica, Colegio de la Salle.

CHIA (Cundinamarca):
Granja Experimental Frutera.

CHINACONTA (Norte de Santander):
Granja Cafetera de Bloñay.

CHINCHINA (Caldas):
Centro Nacional de Investigaciones del Café (Fed. Nac. de Cafeteros).

CUCUTA (Norte de Santander):
Museo de Ciencias Naturales. — Colegio del Sagrado Corazón de Jesús.

FREDONIA (Antioquía):
Granja Cafetera.

IBAGUE (Tolima):
Escuela Agronómica de San Jorge.
Estación Agrícola Experimental.

IPIALES (Nariño):
Granja de Frutales.

LA ESPERANZA (Cundinamarca):
Granja Cafetera Enrique Soto U.

LA PICOTA (Cundinamarca):
Estación Experimental Agrícola.

LIBANO (Tolima):
Granja Cafetera la Union.

MANAURE:
Granja Cafetera de Manaure.

MANIZALES:
Secretaría de Agricultura y Ganadería del Departamento.

MEDELLIN (Antioquia):
Instituto Agrícola Nacional y Escuela Sup. de Agronomía:-
- Depto. de Fitopatología.
- Depto. de Genética.
- Depto. de Suelos.
- Depto. de Fruticultura.
- Depto. de Silvicultura.
- Depto. de Agricultura Especial.

Sección Botánica del Colegio de San José.
Estación Experimental Agronómica.

MONIQUIRA (Boyacá):
Granja Cafetera Berta.

NEIVA (Huila):
Granja Arrocera.

PALMIRA (Valle):
Estación Agrícola Experimental.

PEREIRA (Caldas):
Subestación Experimental de Caña.

PIEDECUESTA (Santander):
Granja Tabacalera de Piedecuesta.

POPAYAN (Cauca):
Escuela de Agricultura de la Universidad del Cauca.
Granja Agrícola la Florida.
Granja Cafetera la Florida.

PUBENZA-GIRARDOT (Cundinamarca):
Subestación Experimental de Caña.

PUERTO TEJADA (El Valle):
Granja Experimental de Cacao.

ROLDANILLO (El Valle):
Estación Agrícola Experimental.

SANDONA (Nariño):
Granja Cafetera Ospina Perez.

SEILLA (Valle):
Granja Cafetera Heraclio Uribe.

SEVILLA (Magdalena):
Estación Agrícola Experimental.

SEVILLA (El Valle):
Granja Cafetera.

SOLEDAD (Atlántico):
Granja Experimental Algodonera.

**TURBACO (Bolivar):**
Granja Experimental Agrícola.

**VENECIA (Antioquía):**
Granja Cafetera de las Mercedes.

**VILLAMARIA (Caldas):**
Granja Frutera Experimental.

● ● ●

**Academia Colombiana de Ciencias Exactas, Físico-Químicas y Naturales, Sección de Ciencias Naturales.** — Apartado No. 2584, Bogotá.
**American Society of Agricultural Sciences, Colombian Chapter.** — Sec.: R. Pedraza, Min. de la Economía Nacional, Bogotá.
**Comisión de Botánica del Valle del Cauca.** — Ap. 570, Cali.
**Sociedad de Agricultores de Colombia.** — Carrera 8a, Número 11-62, Bogotá.
**Sociedad de Ciencias Naturales de Bogotá.** — Bogotá.
**Sociedad Científica Caldas.** — Colegio de San José, Medellín.
**Sociedad Colombiana de Horticultura.** — Pres.: Sra. S. García de Samper, Instituto de Ciencias Naturales de la Universidad Nacional, Bogotá.
**Sociedad Colombiana de Orquídeas.** — Bogotá.
**Sociedad Geográfica de Colombia.** — Ap. 2584, Bogotá.

## — *COSTA RICA* —

**CAIRO (Junta á Siguirres):**
Experimental Rubber Plantations of the Goodyear Rubber Co.

**SAN JOSE:**
Escuela de Ciencias de la Universidad de Costa Rica.
Sección Botánica del Liceo de Costa Rica.
Museo Nacional de Costa Rica. — Ap. 593.

**SAN PEDRO DE MONTES DE OCA:**
Escuela Nacional de Agricultura (Fac. de Agronomía Univ. de Costa Rica).
Departamento Nacional de Agricultura:-
- Servicio Experimental.
- Servicio de Química Agrícola.
- Servicio de Sanidad Vegetal.
- Servicio de Conservación de Suelos.
- Servicio de Botánica.

Instituto de Defensa del Café.

**TURRIALBA:**
Instituto Interamericano de Ciencias Agrícolas. — Apart. 74.
Rubber Breeding Station of the U. S. Dept. of Agric.

● ● ●

**American Society of Agricultural Sciences, Costa Rican Chapter.** — Sec.: D. Martínez, Ap. 1804, San José.

## — *CUBA* —

**CAMAGÜEY (Camagüey):**
Granja Agrícola.

**CENTRAL LIMONES (Matanzas):**
Estación Experimental de la Caña.

**CIENFUEGOS (Santa Clara):**
Atkins Institution of the Arnold Arboretum of Harvard University. — Soledad.

**COLON (Matanzas):**
Granja Agrícola.

**HABANA (Habana):**
Universidad Nacional:-
- Departamento de Biología.
- Escuela de Ingenieros Agrónomos y Azucareros. — Carlos Tercero e Infanta.
- Museo de Historia Natural "Felipe Poey".
- Jardín Botánico. — Carlos Tercero e Infanta.

Sección de Botánica del Colegio de La Salle. — Vedado.
Ministerio de Agricultura:-
- Depto. de Sanidad Vegetal.
- Vivero y Escuela Forestal de la Ciénaga.
- Depto. de Agrónomos del Estado.
- Museo Agrícola.

Junta Provincial de Agricultura de la Habana. — Gobierno Provincial.
Jardín Botánico del Instituto de la Habana. — Carlos Tercero e Infanta.

**PINAR DEL RIO (Pinar del Río):**
Granja Agrícola y Vivero Forestal.
Jardín del Instituto Provincial.

**SAN JUAN Y MARTINES (Pinar del Río):**
Estación Experimental del Tabaco.

**SANTA CLARA (Santa Clara):**
Granja Agrícola.
Estación Experimental de la Seda. — Granja Agrícola.

**SANTIAGO DE CUBA (Oriente):**
Granja Agrícola.

**SANTIAGO DE LAS VEGAS (Habana):**
Estación Experimental Agronómica.

● ● ●

**Academia de Ciencias** (owner of the Herb. Sauvalle). — Habana.
**American Society of Agricultural Sciences, Cuban Chapter.** — Habana.
**Asociación Nacional de Horticultura.** — Ap. 297, Habana.
**Asociación de Técnicos Azucareros de Cuba.** — Edificio Manzana de Gomez 516, Habana.
**Sociedad Cubana de Biología y Medicina Tropical.** — Instituto Finlay, Habana.
**Sociedad Cubana de Historia Natural "Felipe Poey".** — Universidad Nacional, Habana.
**Sociedad Cubana de Microbiología.** — Instituto Finlay, Habana.

## — *CURAÇAO* —

**WILLEMSSTAD:**
Dept. of Agriculture.
Dept. of Biology of Peter Stuyvesant College.
Dept. of Biology of Saint Thomas College.

## — *DOMINGO* —
## — (*Santo Domingo, West Indies*) —

**CIUDAD TRUJILLO (olim: Santo Domingo)*:**
Universidad de Santo Domingo:-
- Instituto de Investigaciones Botánicas.
- Facultad de Agronomía y Veterinaria.

Secretaría de Estado de Agricultura, Industria y Trabajo.

**JAINA:**
Vivero Forestal y Jardín de Aclimatación. — Granja Modelo "Ramón Cáceres".
Servicio del Foresta, Caza y Pesca. — Granja Modelo "Ramón Cáceres".
Laboratorio de Entomología, Fitopatología y Sanidad Vegetal. — Granja Modelo "Ramón Cáceres".

● ● ●

**American Society of Agricultural Sciences, Rep. Dominicana Chapter.** — Sec.: J. M. Gonzáles, hijo, Secret. de Est. de Agric., Ciudad Trujillo.

## —*DOMINICA* —
## — (*Leeward Islands, West Indies*) —

**ROSEAU:**
Agricultural Dept. and Botanic Gardens (govt. inst., affil. to Imp. Coll., Trinidad).

## — *ECUADOR* —

**AMBATO:**
Quinta Normal de Agricultura y Estación Experimental.

**GUAYAQUIL:**
Cámara de Agricultura de la Segunda Zona. — Calle Escobedo 1214.
Dirección de Agricultura del Litoral.

**QUEVEDO:**
Estación Experimental Agrícola del Ecuador.

**QUITO:**
Universidad Central:-
- Instituto Botánico.
- Escuela Superior de Agronomía.

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*N.B.: The Instituto Científico Dominica-Alemán has been closed.

**Instituto Ecuatoriano de Ciencias Naturales.** — Ap. 408.
**Dirección General de Agricultura y Ganadería, División de Agronomía.**

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**American Society of Agricultural Sciences, Ecuador Chapter.**
**Consorcio de Centros Agrícolas.** — Portoviejó, Manabí.
**Sindicato de Técnicos Agrícolas.** — Ambató.
**Sociedad Ecuatoriana de Biología.** — Quito.
**Sociedad Nacional de Agricultura.** — Calle García Moreno 60, Quito.

## — *FALKLAND ISLANDS* —

**PORT STANLEY:**
**Dept. of Agriculture.**
**Falkland Island Museum.**

• • •

**Falkland Islands Horticultural Society.** — Port Stanley.

## — *FRENCH GUIANA* —

**CAYENNE:**
**Services de la Colonisation et Jardin Botanique.**

## — *GUADELOUPE (West Indies)* —

**BASSE TERRE:**
**Département Forestier du Service de l'Agriculture.**
**POINTE à PITRE:**
**Service de l'Agriculture et Jardin d'Essais.**

## — *GUATEMALA* —

**CHIMALTENANGO:**
**Escuela Nacional de Agricultura.** — Finca la Alameda.
**GUATEMALA:**
**Cátedra de Botánica, Fac. de Ciencias Naturales y Farmacia, Universidad Nacional.**
**Oficina Central del Café.**
**Instituto Químico-Agrícola Nacional.** — La Aurora.
**Dirección General de Agricultura:-**
- **Depto. de Sanidad Vegetal.**
- **Herbario Nacional.**
- **Depto. de Plantas Medicinales.**
- **Depto. de Reforestación.**

**Jardín Botánico.** — Boulev. 30 de Junio.
**Escuela de Agricultura.** — Finca Bárcenas.

## — *REP. HAITI (West Indies)* —

**DAMIEN (Port au Prince):**
**Ecole Pratique d'Agriculture.**
**Station Centrale d'Expérimentation Agricole:-**
- **Section d'Agronomie et Horticulture.**
- **Section d'Agrologie et Technologie Agricole.**
- **Section de Botanique et Phytopathologie.**
- **Section du Café.**
- **Section de Sylviculture et Conservation des Sols.**

**FONDS DES NEGRES:**
**Station Expérimentale de Café.**
**KENSKOFF:**
**Station Expérimentale de Sylviculture.**
**MARFRANC:**
**U. S. Dept. of Agriculture Rubber Plant Field Sta.**

## — *REP. HONDURAS* —

**LA LIMA:**
**Research Laboratory of the Tela Railroad Co.** (subsidiary of the United Fruit Company).
**TEGUCIGALPA:**
**Ministerio de Fomento Agricultura y Trabajo.**
**Museo Nacional.**
**Escuela Agrícola Panamericana.** — Ap. 93.
**SAN PEDRO SULA:**
**Jardín Botánico "Pérez Estrada".**
**TELA:**
**Lancetilla Experiment Station of the Tela Railroad Co.** (subsidiary of the United Fruit Company, at which the U. S. Dept. of Agriculture has one of its tropical bases for study and propagation of rubber-producing plants).

## — *JAMAICA (West Indies)* —

**HOPE:**
**Department of Science and Agriculture:-**
- **Div. of Agricultural Chemistry.**
- **Div. of Botany.**
- **Div. of Plant Pathology.**
- **Div. of Banana Leaf Spot Control.**
- **Div. of Forestry.** ✓
- **Div. of Public Gardens** (Hope Gardens; Castleton Gardens; Hill Gardens, Cinchona; King's House Gardens; Bath Gardens).

**Forestry Department.**
**KINGSTON:**
**Cedar Grove Experiment Station of the United Fruit Co.** — Gregory Park P. O.
**Experiment Station of the Marketing Department.** — West End.
**Museum of the Institute of Jamaica.**

• • •

**Jamaica Agricultural Society.** — 11 North Parade, Kingston.
**Jamaica Horticultural Society.** — 5 Retirement Crescent, Cross Roads.
**Manchester Horticultural Society.** — Mandeville.

## — *MARTINIQUE (West Indies)* —

**FORT-DE-FRANCE:**
**Laboratoires et Jardins du Service de l'Agriculture.**
**Museum Océanographique de M. L. Conseil.**

## — *MEXICO* —

**BRISEÑAS, Mich.:**
**Campa Agrícola Experimental.**
**CHAPINGO, D. F.:**
**Escuela Nacional de Agricultura.**
**CIUDAD JUAREZ, Chih.:**
**Escuela Particular de Agricultura.**
**COLONIA ANAHUAC, D. F.:**
**Laboratorio Entomológico** (Bureau of Ent. and Pl. Quar., U.S.D.A.). — Calzada Tacuba 295.
**ESCUINTLA, Chis.:**
**Instituto Biológico.**
**Matuda Herbarium.** — Ap. 20.
**GUADALAJARA, Jal.:**
**Sección de Botánica Médica, Universidad de Guadalajara.**
**GUATIMOC, Cacahoatán, Chiapas:**
**Estación Experimental y Plantaciones de Quinas** (Depto. de Salubridad Pública).
**GUTIERREZ ZAMORA, Ver.:**
**Campo Agrícola Experimental.**
**LEON, Gto.:**
**Campo Agrícola Experimental.**
**LLERA, Tamps.:**
**Campo Agrícola Experimental.**
**MERIDA, Yuc.:**
**Instituto Técnico Agrícola Henequenero.** — Ap. 183.
**MEXICO, D. F.:**
**Depto. de Botánica del Instituto de Biología de la Universidad Nacional.** — Casa del Lago, Chapultepec.
**Escuela Nacional de Ciencias Biológicas del Instituto Politécnico Nacional.** — Av. de los Maestros, Prolongación de Lauro Aguirre, Colónia Santo Tomás, Ap. Postal 7016:-
- **Depto. de Botánica.**
- **Depto. de Bacteriología Industrial y Zimología** (Lab. "Louis Pasteur").

**Depto. de Biología de la Escuela Nacional Preparatoria.** — San Ildefonso 43.
**Departamento Forestal y de Caza y Pesca.** — Calle de Edison 145.

**Dirección General de Agricultura** (Has the collections, herbarium, etc. of the now defunct Instituto Biotécnico). — San Jacinto:-
Depto. Fito-Sanitario.
Depto. de Ingenieria Rural.
Depto. de Química.
Depto. de Campos Experimentales.
Depto. de Industrias.
**Sección de Bromatología (Botánica) del Instituto Pecuario.** — Av. de los Maestros 116, San Jacinto.
**Instituto de Enfermedades Tropicales, Sección de Botánica Médica.** — Plan de San Luís y Prolongación de Carpio, San Jacinto.
**Museo Nacional de Historia Natural de México.** — La del Chopo 10.
**Museo de la Flora y Fauna.** — Chapultepec.
**Jardín Botánico.** — Chapultepec.

MONTERREY, N. L.:
**Instituto de Investigaciones Científicas de la Universidad de Nuevo León.** — Apart. postal 897.
Sección de Historia Natural.

MORELIA, Mich.:
**Depto. de Botánica y Herbario, Universidad Michoacana.**
**Museo Michoacana.**

OAXACA, Oax.:
**Campo Agrícola Experimental.**

PABELLON, Ags.:
**Campo Agrícola Experimental.**

EL PALMAR, Ver.:
**Campo Agrícola Experimental.**

PATZCUARO, Mich.:
**Estación Limnológica de Pátzcuaro** (Sec. de la Marina Nac.).

QUERETARO, Qro.:
**Campo Agrícola Experimental.**

SALTILLO, Coah.:
**Escuela de Agricultura del Estado.**

TACUBAYA, D. F.:
**Lab. de Biología del Instituto Zaragoza.** — Observatorio 80.

TLALNEPANTLA, Méx.:
**Campo Agrícola Experimental.**

TORREON, Coah.:
**Campo Agrícola Experimental.**

VERACRUZ:
**Estación Forestal del Puerto de Veracruz.**

EL YAQUI - OBREGON, Son.:
**Campo Agrícola Experimental.**

ZACATEPEC, Mor.:
**Campo Agrícola Experimental.**

• • •

**Academia Nacional de Ciencias "Antonio Alzate".** — Calle de Justo Sierra 19, México, D. F.
**American Society of Agricultural Sciences, Mexican Chapter.** — Ap. 2433, México, D. F.
**Garden Club of Mexico City.** — México, D. F.
**Sociedad Agronómica Mexicana.** — Calle Cinco de Mayo 40; Ap. 2433, México, D. F.
**Sociedad Agrostológica Mexicana.** — Campeche 293, México, D. F.
**Sociedad Alejandro de Humboldt.** — Apart. 318, México, D. F.
**Sociedad de Amigos de las Orquídeas.** — Calle de Durango 18, México, D. F.
**Sociedad Botánica de México.** — 2a Calle de Morelia 61, México, D. F.
**Sociedad de Biología y Ciencias Afines.** — José Mariano Mociño, Escuela Nacional Preparatoria, San Ildefonso 43, México, D. F.
**Sociedad Forestal Mexicana.** — Calle del Elisé, México, D. F.
**Sociedad Mexicana de Biología.** — Ramón Guzmán 34, México, D. F.
**Sociedad Mexicana de Historia Natural, Sección de Botánica.** — Ap. postal 1079, México, D. F.
**Sociedad Mexicana de Microbiología.** — Sec.: Dr. M. Ruiz Castañeda, México, D. F.

## — *MONTSERRAT (West Indies)* —

GROVE:
**Grove Botanic Station.**

## — *NETHERLANDS GUIANA* — — *(Surinam)* —

DIRKSHOOP:
**Citrus Experiment Field** (Proefveld voor de Citruscultuur) (Dept. of Agric.).

PARAMARIBO:
**Agricultural Expt. Station** (Landbouwproefstation).
**Forest Service** (Dienst van het Boschwezen).

## — *NICARAGUA* —

CHINANDEGA:
**Escuela Nacional de Agricultura.**
**Estación Experimental.**

MANAGUA:
**Servicio Técnico Agrícola.**
**Escuela Nacional de Agricultura** (being established).
**Sección Botánica del Museo Nacional.**

MASATEPE:
**Centro Experimental Agrícola.**

EL RECREO:
**Estación Experimental Agrícola.**

## — *PANAMA (Canal Zone)* —

BALBOA:
**Canal Zone Branch of the Bureau of Entomology and Plant Quarantine of the U.S.D.A.**

BARRO COLORADO (Frijoles P. O.):
**Barro Colorado Island Biological Laboratory of the Institute for Research in Trop. America.**

SUMMIT:
**Canal Zone Experiment Gardens** (Under the jurisdiction of the Panama Canal, co-operates with the U.S. D.A., esp. with the Div. of Sugar Plant Investigations).

• • •

**Canal Zone Orchid Society.** — Pres. W. Cope, Pedro Miguel, C. Z.
**Canal Zone Natural History Society.** — Pres. J. Zetek, Balboa, C. Z.

## — *PANAMA (Republic)* —

DAVID:
**Sección de Fomento Agrícola de la Provincia de Chiriqui.**

DIVISA:
**Instituto Nacional de Agricultura.**

PANAMA:
**Depto. de Botánica, Instituto Nacional y Universidad Nacional de Panamá.**
**Sección de Botánica, Museo Nacional de Panamá.**
**Gorgas Memorial Laboratory.**

SANTIAGO DE VERAGUAS:
**Escuela Normal.**

## — *PARAGUAY* —

ASUNCION:
**Ministerio de Agricultura:-**
Dirección General de Agricultura.
Escuela Nacional de Agricultura "Mariscal Estigarribia".
Dirección de Laboratorios.
Jardín Botánico.

PUERTO BERTONI:
**Estación Agronómica Experimental.**
**Museo Bertoni.**

• • •

**American Society of Agricultural Sciences, Paraguayan Chapter.** — Sec.: E. Fernández, Min. de Agricultura, Asunción.
**Sociedad Científica del Paraguay.** — Asunción.
**Sociedad Nacional de Agricultura.** — Presidente Franco 12, Asunción.

## — PERU —

**AREQUIPA:**
Universidad Nacional San Augustin:-
Gabinete de Botánica.
Estación Agrícola.

**CAÑETE:**
Estación Experimental de la Asociación de Hacendados de Cañete.

**CHUQUIBAMBILLA:**
Granja-Modelo de Puno.

**CONCEPCION:**
Estación Agrícola de Junin.
Sub-Estación de Genética de Cereales.

**CUZCO:**
Universidad Menor de Cuzco:-
Depto. de Botánica.
Museo de Historia Natural, Sección Botánica.
Granja Escuela Agrícola de Kcaira.

**HUARAZ:**
Estación Agrícola de Ancash.

**IQUITOS:**
Estación Agronómica de Loreto y Ucayali.
Instituto Técnico Químico-Industrial del Oriente.

**LAMBAYEQUE:**
Estación Experimental Agrícola del Norte:-
Sección Agrícola.
Sección Fruticultura.
Sección Genética Vegetal.
Sección de Sanidad Vegetal.

**LIMA:**
Universidad Mayor de San Marcos:-
Fac. de Ciencias:-
Laboratorio de Botánica. — Parque Universitario.
Fac. de Ciencias Económicas:-
Escuela de Agricultura y Veterinaria.
Instituto de Farmacia.
Museo de Historia Natural "Javier Prado". — Av. Arenales, c. 12, Cas. 1109.
Escuela Nacional de Agricultura y Veterinaria. — Ap. 456.
Estación Experimental Agrícola de La Molina (Instituto de Altos Estudios):-
Departamento de Agronomía.
Departamento de Genética Vegetal.
Servicio de Entomología.
Servicio de Fitopatología.
Servicio de Química y Suelos.
Servicio de Fruticultura.
Instituto Técnico Químico Industrial del Oriente y Servicio Forestal del Perú:-
Sección Química Industrial y Farmacéutica.
Sección Selvicultura.
Ministerio de Fomento:-
Dirección de Agricultura y Ganadería.
Sección Técnica de Defensa Agrícola.
Dirección de Tierras de Montaña y Colonización.
Instituto Nacional de Microbiología Agrícola, Sueros y Vacunas. — Ap. 1284.
Instituto de Genética del Algodón de la Soc. Nac. Agraria. — Ap. 850.
Museo Nacional de la República. — Plaza Bolivar, Magdalena Vieja.

**MOQUEGA:**
Estación Agronómica.

**OROMINA (Río Huallaga):**
Estación Impulsora del Cultivo y Explotación del Jébe (Dir. de Tierras, Min. de Fom.; Trop. Agric., Hevea).

**PIURA:**
Estación Agronómica.
Sub-Estación de Genética de Algodón y Semillero Oficial. — Hda. Nahihualá.

**PUNO:**
Sección Experimental de la Granja Taller Salcedo (3750 m.s.m.).

**SATIPO:**
Granja de Colonización.

**TACNA:**
Estación Agronómica.

**TINGO MARIA:**
Estación Experimental Agrícola.
Granja de Colonización (Dir. de Tierras, Min. de Fom.).

**TRUJILLO:**
Universidad Nacional:-
Gabinete de Botánica.
Servicio Agronómico Ambulante de la Libertad.

● ● ●

Academia Nacional de Ciencias Exactas, Físicas y Naturales. — Universidad Mayor de San Marcos, Lima.
Asociación Peruana de Ingenieros Agrónomos. — Ap. 1402, Lima.
Asociación Peruana para el Progreso de la Ciencia. — Ap. 1964, Lima.
Centro de Estudiantes de Agronomía. — Ap. 456, Lima.
Sociedad de Biología, Academia de Medicina. — Lima.
Sociedad Nacional Agraria. — Núñez 226 A, Lima.
Sociedad Peruana de Historia de la Medicina. — Pres.: Dr. C. E. Paz Soldán, Lima.

## — PUERTO RICO —

**ISABELA:**
Substation of the Experiment Station of the Univ. of Puerto Rico.

**MAYAGÜEZ:**
College of Agriculture and Mechanic Arts of the Univ. of Puerto Rico.
Institute of Tropical Agriculture of the Univ. of Puerto Rico.
Puerto Rico Experiment Station of the U. S. Dept. of Agriculture.
Research Station of the Soil Conservation Service of the U.S.D.A.
Fisheries Laboratories (Dept. of Agric. in co-op. with U. S. Bureau of Fisheries).

**RIO PIEDRAS:**
University of Puerto Rico:-
Dept. of Biology.
Agricultural Experiment Station.
Dept. of Genetics.
Dept. of Phytopathology.
Dept. of Phytotechnics.
Dept. of Plant Physiology.
Dept. of Soils.
Tropical Forest Experiment Station (U.S.D.A.).
Caribbean National Forest (U.S.D.A.).
Research Station of the Soil Conservation Service of the U.S.D.A.
Tobacco Institute.

**SAN JUAN:**
Departamento de Agricultura, Industria y Comercio (Gobierno Insular):-
Servicio de Sanidad Vegetal.
Div. de Fomento Agrícola.
Museo.
Soil Conservation Service (U.S.D.A.).
School of Tropical Medicine (U. of P. Rico and Columbia U. coöperating).

● ● ●

American Society of Agricultural Sciences, P. R. Chapter. — Sec.: Dr. J. A. Bonnet, Box 591, Río Piedras.
Britton-Stahl Botanical Club. — Río Piedras.
Sociedad de Agrónomos de Puerto Rico. — Bayamón.

## — ST. KITTS-NEVIS (West Indies) —

**LA GUÉRITE:**
Agricultural Experiment Station.

## — SALVADOR —

**SAN ANDRES:**
Centro Nacional de Agronomía.

**SAN SALVADOR:**
Laboratorios del Ministerio de Agricultura:-
Depto. Botánico.
Depto. Químico.

**SANTA TECLA:**
Escuela de Agronomía.
Colegio Salesiano de Agricultura de "Ayagualo".
Servicios Técnicos de la Asociación Cafetalera.

## — TRINIDAD AND TOBAGO —

**MARPER ESTATE:**
Agricultural Experiment Station.

**PORT OF SPAIN:**
Head Office and Laboratories of the Dept. of Agriculture.
Forest Department. — P. O. Box 213.
Museum of the Victoria Institute.
Royal Botanic Gardens.

**RIVER ESTATE:**
Agricultural Experiment Station.

**ST. AUGUSTINE:**
Imp. College of Tropical Agriculture:-
- Dept. of Agric. Chemistry and Soil Science.
- Dept. of Agriculture.
- Dept. of Botany.
- Dept. of Mycology and Bacteriology.
- Low Temperature Research Station.

Cotton Research Station of the Empire Cotton Growing Corporation.
Agricultural Experiment Station (Dept. of Agric.).
St. Augustine Nursery.

**TOBAGO:**
Botanic Garden and Agricultural Experiment Station.

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Agricultural Society of Trinidad and Tobago. — Port of Spain.
Horticultural Club of Trinidad and Tobago. — Port of Spain.

## — URUGUAY —

**BAÑADO DE MEDINA (Cerro Largo):**
Escuela de Práctica y Campo Experimental de Agronomía.

**LA ESTANZUELA (Depto. Colonia):**
Instituto Fitotécnico y Semillero Nacional La Estanzuela (Min. de Gan. y Agric.).

**MONTEVIDEO:**
Instituto de Biología.
Facultad de Agronomía, Universidad de la República:-
- Cátedra de Agricultura.
- Cátedra de Botánica Agrícola.
- Cátedra de Bromatología.
- Cátedra de Fitopatología.
- Cátedra de Fruticultura y Viticultura.
- Cátedra de Horticultura.
- Cátedra de Indústrias Agrícolas.
- Cátedra de Microbiología.
- Cátedra de Silvicultura.

Fac. de Química y Farmacia, Univ. de la República:-
- Sección Botánica.

Estación de Patología Vegetal y Entomología (Min. de Gan. y Agric.). — Av. Millán 4749.
Estación Experimental del Frío. — Av. Garzón 780.
Estación Experimental de Riego "Ing. Luis A. Zunino". — Garzón 780.
Sección Botánica del Museo de Historia Natural. — Cas. 399.
Sección Botánica del Laboratorio de Ciencias Biológicas. — Av. Millán 4096.
Herbario Osten. — Bartolomé Mitre 1264.
Herbarium Herter. — Calle Pedro I, 777 (Cf. Chron. 6:428).
Jardín Botánico y Museo Botánico. — Av. Reyes 1179.

**PAYSANDU:**
Escuela de Práctica y Campo Experimental de Agronomía.

**TOLEDO (Canelones):**
Instituto Forestal (Min. de Gan. y Agric.).

● ● ●

American Society of Agricultural Sciences, Uruguayan Chapter. — Sec.: F. Cassamagnaghi, 25 de Mayo 555, 5. Piso, Montevideo.
Asociación de Ingenieros Agrónomos. — Av. Agraciada 146, 13. Piso, Montevideo.
Sociedad de Biología. — Casilla de Correo 567, Montevideo.
Sociedad Linneana. — Av. Millán 4096, Montevideo.

## — VENEZUELA —

**CARACAS:**
Ministerio de Agricultura y Cría:-
- Instituto Nacional de Agricultura:-
  - Depto. de Fitopatología.
  - Depto. de Genética.
  - Depto. de Suelos.
- Escuela Superior de Agricultura.
- Servicio de Fitopatología.
- Servicio de Botánica. — Ap. 255.
- Servicio de Genética.
- Servicio de Microbiología General.
- Servicio de Horticultura.
- Servicio de Suelos.

Escuela Superior de Agricultura. — El Valle.
Museo Comercial. — Paraíso Poleo 83-1.

**MARACAY (Estado Aragua):**
Escuela Práctica de Agricultura de Maracay.

● ● ●

Academia de Ciencias Físicas, Matemáticas y Naturales. — Caracas.
American Society of Agricultural Sciences, Venezuelan Chapter. — Sec.: R. Pinto S., Inst. de Agricultura, El Valle.
Sociedad Venezolana de Ciencias Naturales. — Avenida del Paraiso; Ap. 1521, Caracas.
Sociedad Venezolana de Microbiología, Parasitología y Medicina Tropical. — Clínica Razett, Caracas.

## — VIRGIN ISLANDS —

**ST. CROIX:**
Agricultural Experiment Station (U. S. Dept. Agr.).

## — WINDWARD ISLANDS —

**GRENADA:**
Botanic Garden. — St. George's.

**ST. LUCIA:**
Union Agricultural Station.

**ST. VINCENT:**
Government Experiment Station and Saint Vincent Botanic Gardens.
Cotton Research Station (Emp. Cotton Grow. Corp.). — Kingstown.

*Complete and Detailed*

# TABLE OF CONTENTS

**As it was not feasible to prepare a subject index for our polyglot volume, it is important that every reader examine this table of contents with some care! It contains in Part I cross-references to Part II and vice versa.**

## PARS I

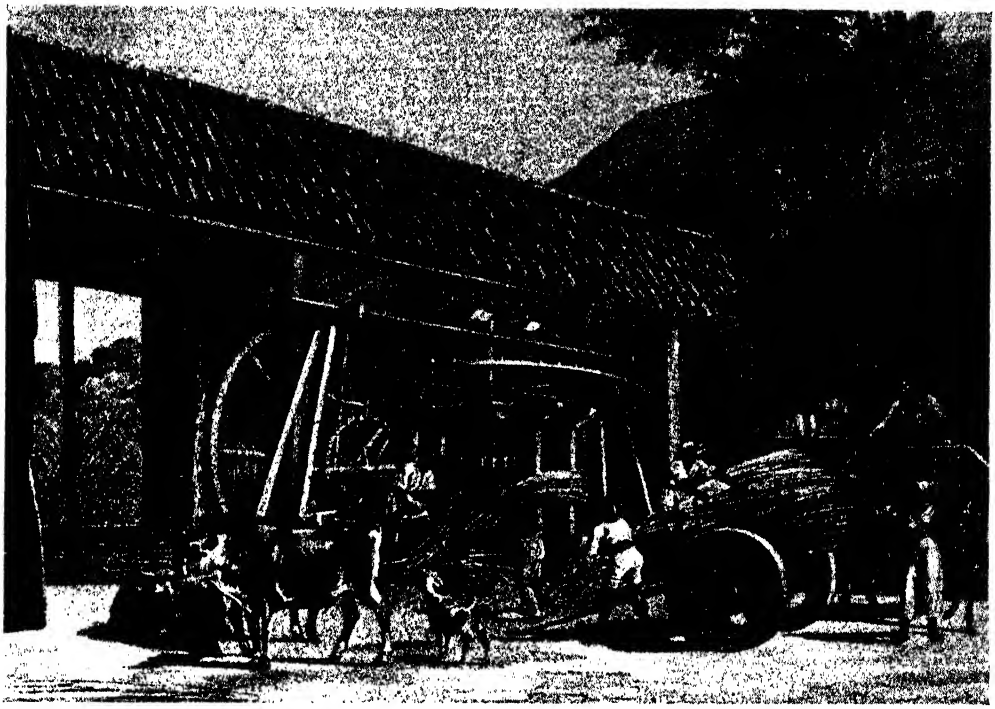

PLATE 27a.—BRAZILIAN SUGAR MILL.—*From* RUGENDA'S "Reise in Brasilien" (1836).

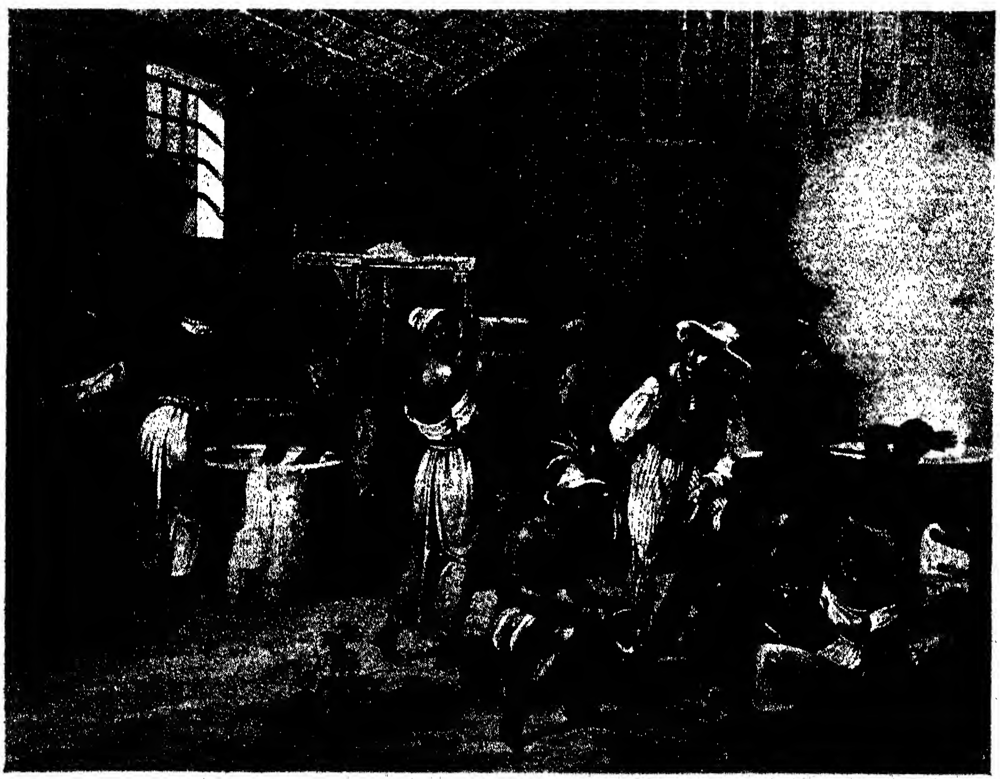

PLATE 27b.—PREPARING MANIOC (CASSAVE).—*From* RUGENDA'S "Reise in Brasilien" (1836).

PLATE 28. — ALEXANDER VON HUMBOLDT (after an engraving by F. G. WEITSCH, reproduced by courtesy of Mrs. R. A. HUNT of Pittsburgh, Pa.). — "Scientifically this expedition gave us our first clear understanding of problems of altitudinal and geographical alignment of vegetation . . . [his] figure remains permanently that of the master of philosophical observation . . ." (PENNELL, p. 40/41, pars I of this volume).

PLATE 29a. — RIO DE JANEIRO IN THE EARLY 19TH CENTURY (showing some cultivated plants, as palms, Cecropia, Agave, banana, Ricinus, etc.) — *From* RUGENDA's "Reise in Brasilien" (1836).

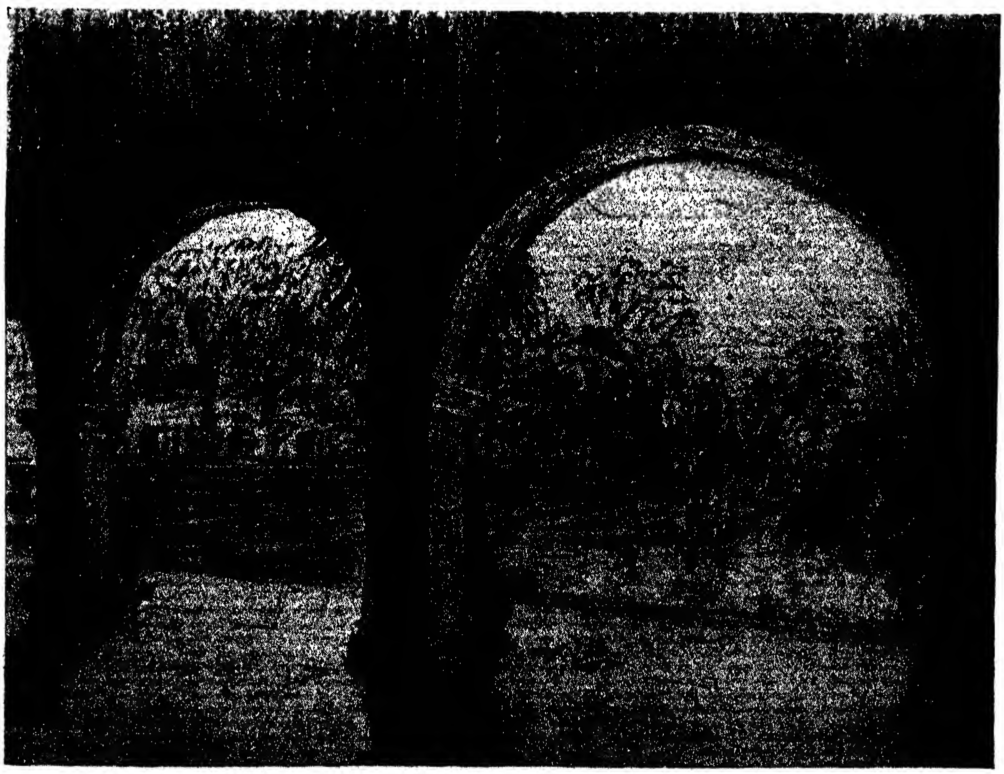

**PLATE 29b. — VISTA OF THE BORDA GARDEN IN CUERNAVACA. — This famous garden was made in the 18th century by a Frenchman, "Père BORDE", who had made a fortune from the silver mines of Taxco. Besides ornamental lakes and fountains, walks and pavilions, the garden contained a remarkable collection of fruit trees — mango, guava, mamey, and many others. In the 19th century, the carden was the residence of the unfortunate MAXIMILIAN and his CARLOTA. More recently it was part of a hotel. At present the hotel is closed and the garden open to visitors. Its colonial charm is preserved in the midst of its decay. — After a drawing by H. W. RICKETT (original).**

PLATE 30. — A VIEW IN THE HARVARD BOTANICAL GARDENS, SOLEDAD ESTATE, CIENFUEGOS, CUBA. THE PALM COLLECTION EMBRACES NEARLY A HUNDRED SPECIES. (Photograph by Dr. E. G. STILLMAN). — For an interesting account of this garden *see* R. M. GREY 1927, Report of the Harvard Botanical Gardens . . . Cuba, 1900/26 (Cambridge: Harvard U.P.).

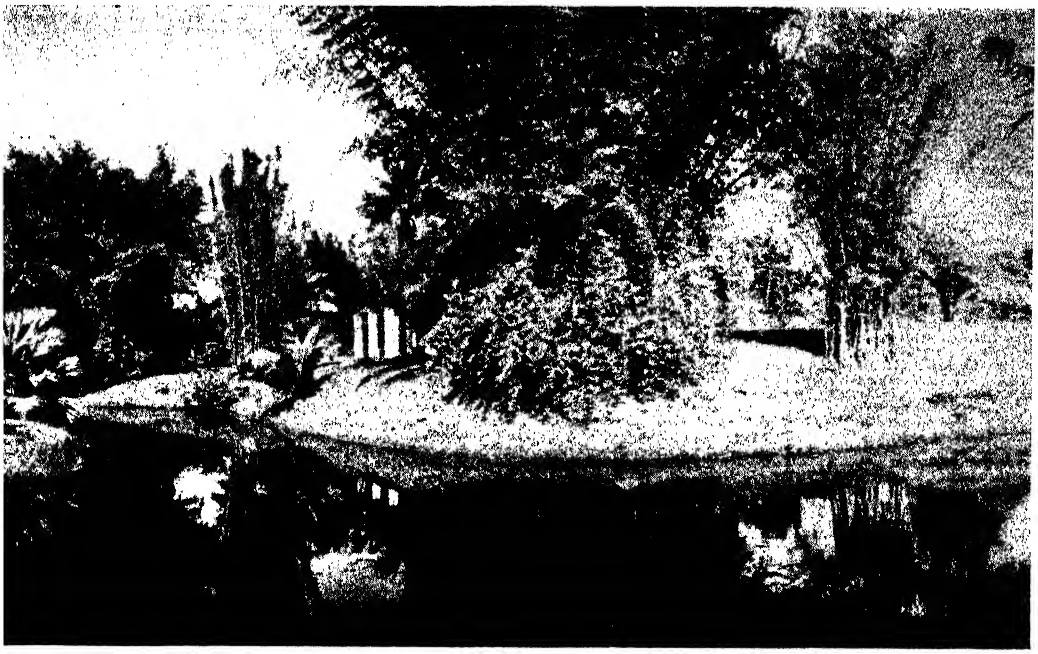

Plate 31. — Coffee plantations in Brazil in the early 19th Century. — Plate XLIV of Martius' *Flora Brasiliensis* ("in praedio inter oppidum Magé et montes Serra dos Orgãos").

PLATE 32. — *Above:* Young *Cinchona* trees of the famous high-yielding *Ledgeriana* strain, growing at the Tingo Maria Tropical Experiment Station in Central Peru. These plants originated from seed brought from Dutch plantations in Java. They will be used to initiate a plantation *Cinchona* industry in Peru. — *Below, left:* Drying wild cinchona bark near Penachi in the department of Lambayeque in northern Peru. The forest from which this bark has been harvested lies on the flanks of the ridge seen in the background. — *Below, right:* Tying up a young rubber plant at the Tropical Experiment Station, Tingo Maria. To the native wild rubber, used here as rootstock, has been budded stock taken from high-yielding, disease-resistant clones. — *Photographs by Dr.* W. H. HODGE.

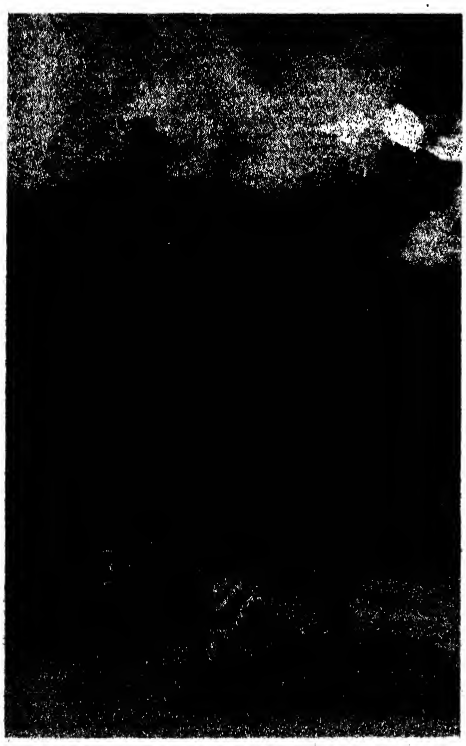

PLATE 33. — TERMITE NESTS AND ANT EATERS ON A DEEPLY ERODED PLATEAU IN BRAZIL. — Tab. physiogn. III of MARTIUS' *Flora Brasiliensis* ("Arboreta in minis novis; taboleiro coberto incolis dicta").

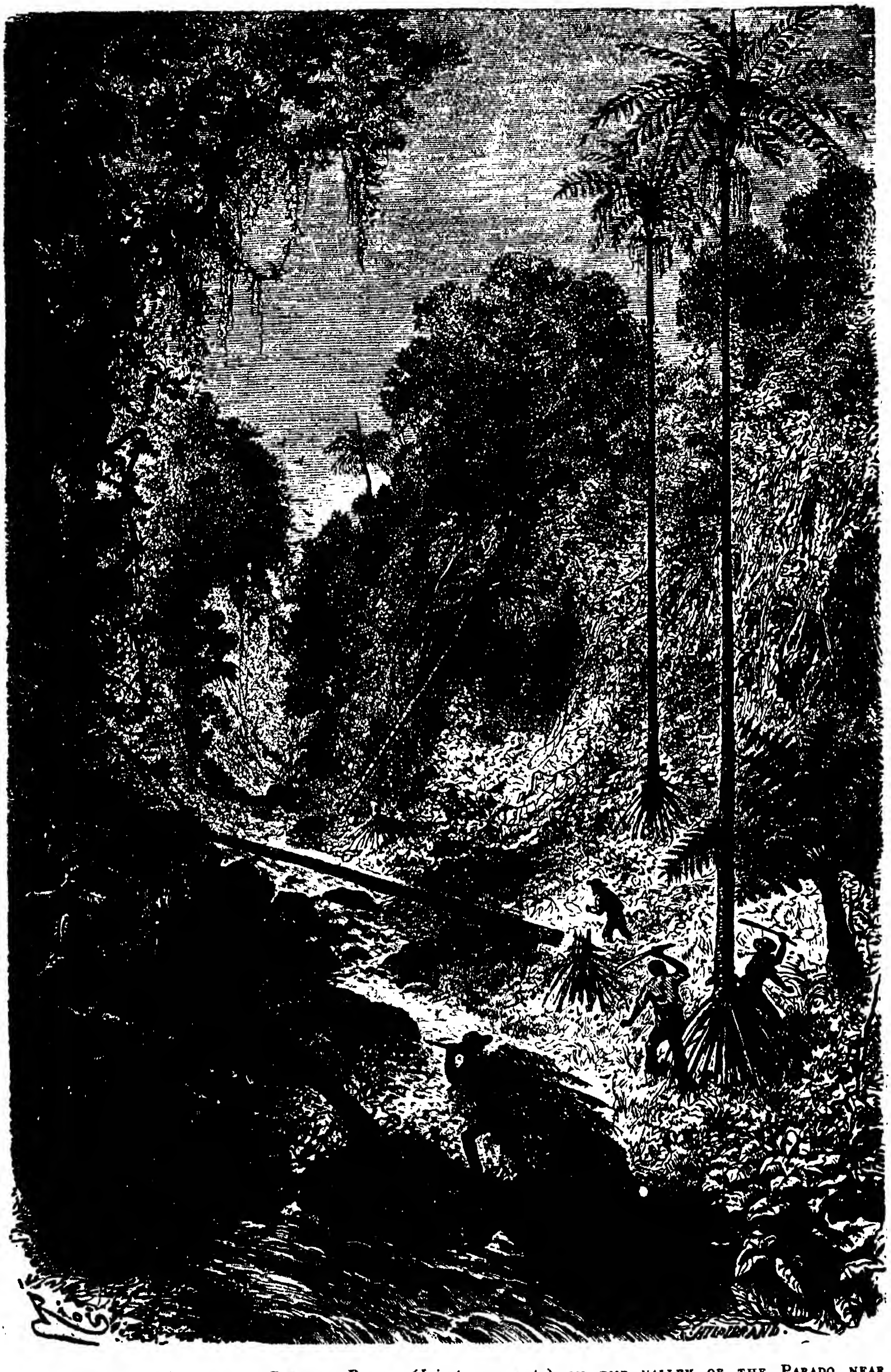

PLATE 34. — COLLECTING CORNETO PALMS (*Iriartea cornuta*) IN THE VALLEY OF THE PARADO NEAR VILLAVICENCIO, COLOMBIA. — *From* E. ANDRÉ's "L'Amérique Équinoxiale".

Special Supplement: —

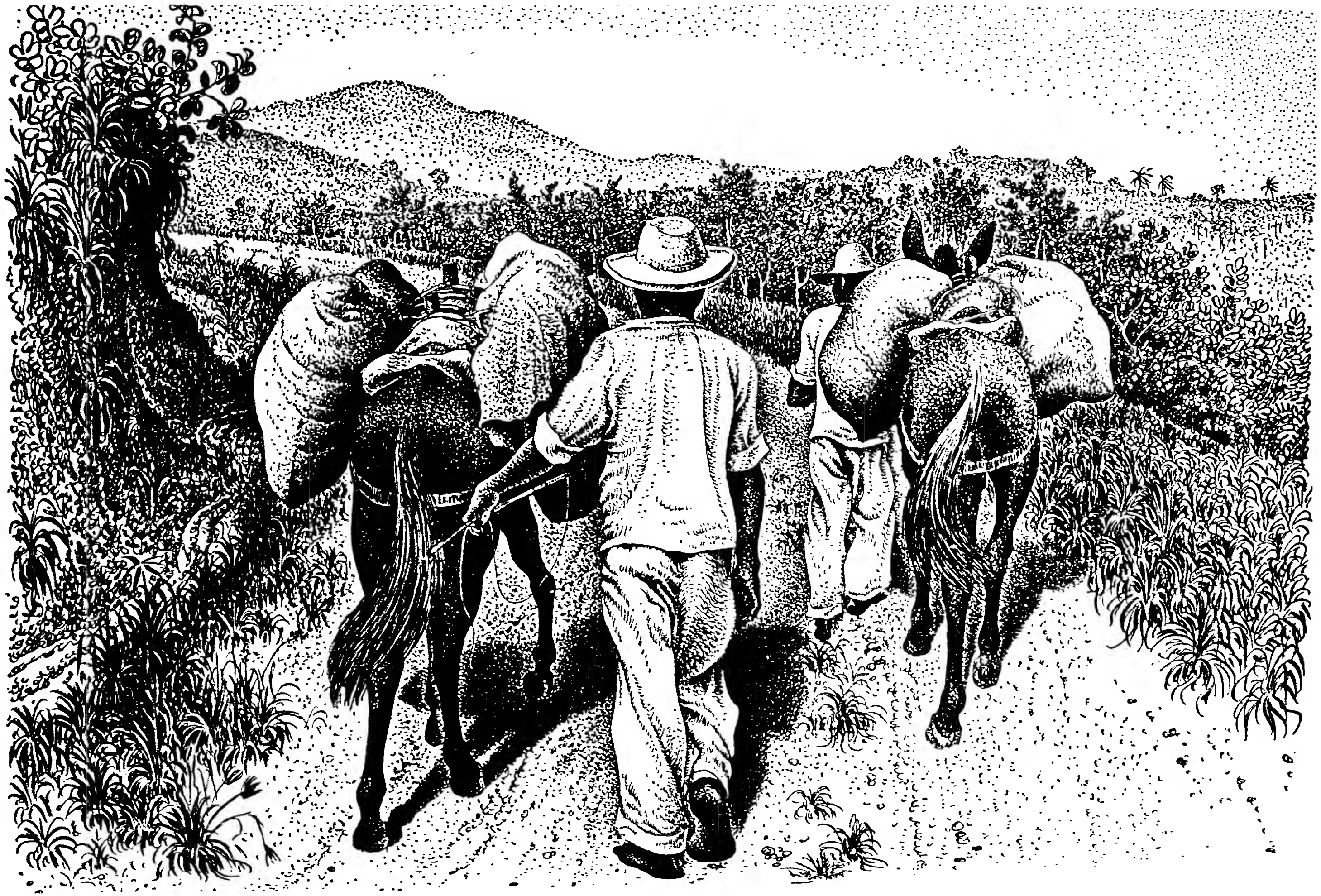

Plate 35. — Packmules, the most important means of transportation for agricultural produce in many regions of tropical America. — *Courtesy Rev. Bras. Geogr.*

## PARS II

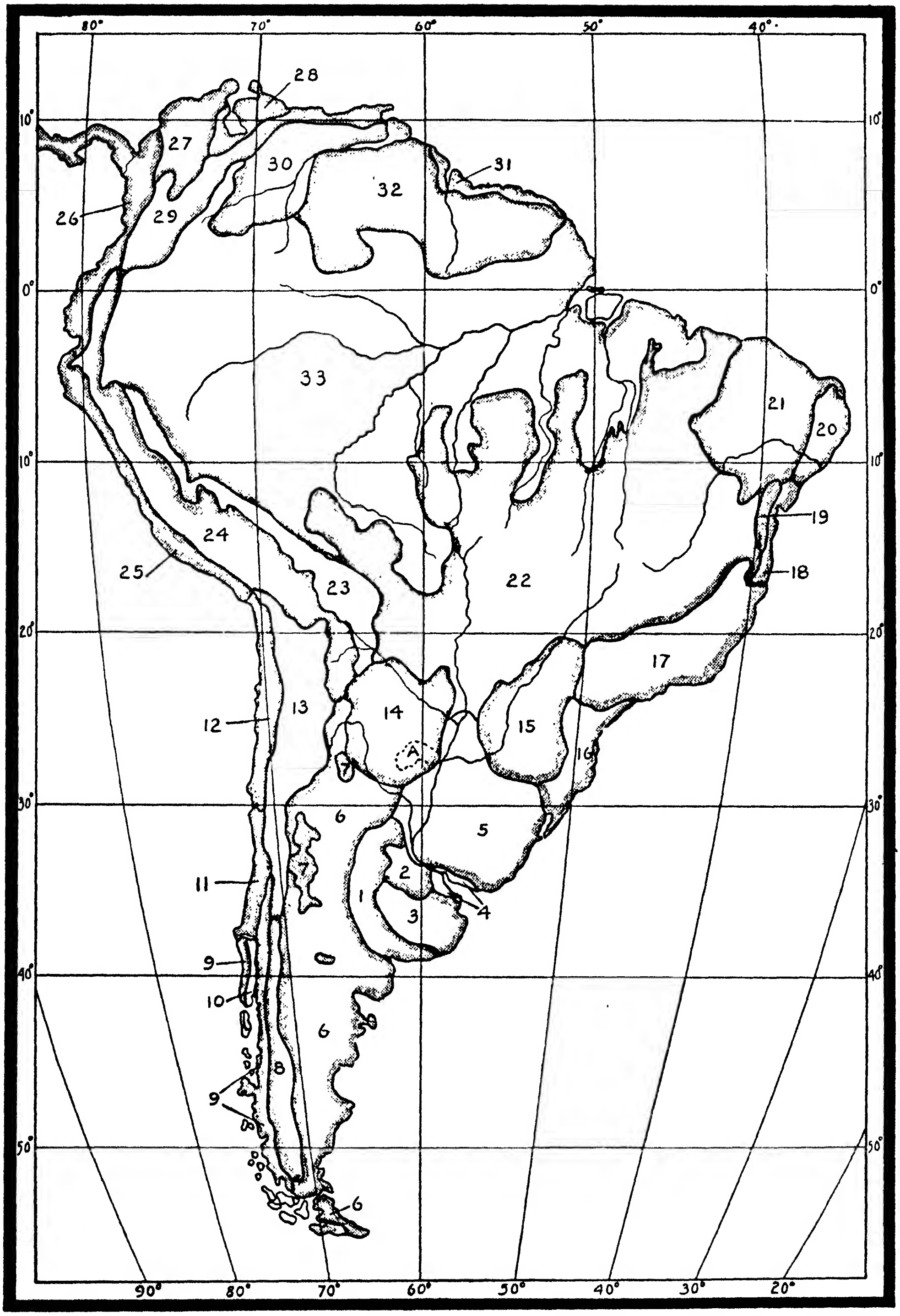


Plate 36. — Agricultural regions of South America (*after* C. F. Jones, *courtesy of Economic Geography*): — 1, wheat crescent; 2, corn-flax region; 3, eastern pampas grazing region; 4, La Plata dairying-specialized farming region; 5, Paraná-Uruguay grazing region; 6, region of differentiated grazing; 7, irrigated oases of western Argentina; 8, South Andean grazing region; 9, Pacific temperate forest; 10, humid pasture-crop-forest region; 11, Mediterranean crops region: A, central valley sub-region, B, coastal valley-mountain sub-region; 12, Chilean coastal desert; 13, arid Andean grazing region; 14, Chaco Quebracho-grazing region: A, chaco-cotton sub-region; 15, subtropical and yerba-maté forest; 16, general farming region of southern Brazil; 17, coffee-general farming region; 18, eastern coastal forest; 19, Baía cacao region; 20, Cotton-sugar region of northeast Brazil; 21, semi-arid grazing and crop region of northeast Brazil; 22, campos grazing region; 23, the yungas; 24, central Andean crops and grazing region; 25, Peruvian irrigated coastal valleys; 26, Pacific margin tropical products region; 27, Magdalena-Cauca region; 28, Maracaibo sugar-cacao region; 29, north Andean crops and grazing region; 30, llanos grazing region; 31, Guianan littoral; 32, Guianan forest and grazing region; 33, Amazonian forest and primitive agriculture.

PLATE 37. — CAMP OF A BOTANICAL COLLECTOR IN VENEZUELA (LOS CENALES). — *From* C. F. APPUN'S "Unter den Tropen" (1871).

CHAPTERS OF A GENERAL (NON-REGIONAL) INTEREST: —

Plate 38. — Collecting Cinchona in the Peruvian Forest. — Woodcut by Laplante, after a drawing by Faguet. — *From* Figuier's "Histoire des Plantes".

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